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T N & Associates, Inc.

Engineering and Science

October 31, 2005

Mr. William Joyner
Remedial Project Manager
U.S. Environmental Protection Agency
61 Forsyth Street, SW 11th Floor
Atlanta, Georgia 30303

Subject: Florida Smelter Company – Berman Brothers Scrap Yard
Site Inspection Final Report
EPA ID No. FLN000407485
EPA Contract No. 68-S4-01-01 (STAT 4)
Task Order No. 0016

Dear Mr. Joyner:

The T N & Associates, Inc. (TN&A) Superfund Technical Assessment Team (STAT) is submitting the report, CERCLA Eligibility form, original topographic map, references cited, scoresheets, and confidential pages for the Florida Smelter Company – Berman Brothers Scrap Yard site (FSC Berman) in Jacksonville, Duval County, Florida.

Please contact me at 678-355-5550 extension 5704 if you have any questions or comments regarding this report.

Sincerely,

Gregory J. Kowalski
STAT Program Manager

Enclosure

CC: Fran Harrell, EPA Contracting Officer (w/o enclosure)
Mike Norman, EPA Task Order Project Officer (w/o enclosure)

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SITE INSPECTION REPORT

FLORIDA SMELTING COMPANY/BERMAN BROTHERS SCRAP YARD
JACKSONVILLE, DUVAL COUNTY, FLORIDA

U.S. EPA ID No. FLN000407485

Revision 0

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Prepared by:

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Contract No.	:	68-S4-01-01
Task Order No.	:	0016
Date Submitted	:	October 31, 2005
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CONTENTS

APPENDICIES

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has tasked the T N & Associates, Inc., (TN&A) Superfund Technical Assessment Team (STAT) to perform a Site Inspection (SI) under Contract Number (No.) 68-S4-01-01 at the Florida Smelting Company/Berman Brothers Scrap Yard (FSC Berman) site, EPA Identification (ID) No. FLN000407485, located in Jacksonville, Duval County, Florida.

The primary objective of a SI is to determine whether a site has the potential to be placed on the National Priorities List (NPL). The NPL identifies sites at which a release, or potential release, of hazardous substances poses a serious risk to the public health or the environment to warrant further investigation and possible remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Information gathered during the SI is used to generate a Hazard Ranking System (HRS) score. The HRS score is the primary criterion EPA uses to determine whether a site should be placed on the NPL. Generally, SIs are conducted at sites where sampling is necessary to fulfill HRS documentation requirements or determine whether a site may be removed from CERCLIS, the CERCLA Information System database. CERCLIS no longer includes sites that EPA has assessed and designated as "No Further Remedial Action Planned," or archive, sites. An archive designation means that, to the best of EPA's knowledge, the Superfund has completed its assessment and determined that no further steps will be taken to list this site on the NPL; however, an archive site is subject to future listing if subsequent information indicates this decision was inappropriate or otherwise incorrect. An archive decision does not necessarily mean that a given site is free of associated hazard; it means only that the location is not considered a potential NPL site based on available information.

Specifically, the objectives of this SI are to accomplish the following:

- Obtain, review, and summarize relevant file material
- Document current site conditions
- Collect samples to determine the nature and extent of contamination
- Collect samples to establish representative background levels
- Identify and summarize human and ecological target populations
- Evaluate groundwater and soil exposure pathways
- Locate any missing HRS data.

This report documents findings of the fieldwork conducted during the week of June 13, 2005, at the FSC Berman site. EPA Region 4 and the Florida Department of Environmental Protection (FDEP) provided the historical information and file documentation used within this report.

2.0 SITE BACKGROUND

This section describes the site and its present and past operations, waste disposal practices, regulatory history, previous investigations, and potential source areas.

2.1 SITE DESCRIPTION

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The FSC Berman Site is located at 2726 Evergreen Avenue, Jacksonville, Duval County, Florida. The geographic coordinates are 30° 21' 19" north latitude and 81° 38' 38" west longitude (see Figure 1) (Refs. 1, 2). FSC Berman was identified in a 2001 study of former lead smelting facilities that was published in the *American Journal of Public Health* and reported by ABC News (Refs. 3, 4). The study identified approximately 430 former lead smelting sites that may contain potentially hazardous soil lead levels and are "unrecognized in the United States". FSC Berman is one of the sites listed (Ref. 3). A second FSC listing at 17th and Evergreen is also posted, but when mapped, is identified at the same location (Ref. 5).

Berman Bros, Inc. now occupies the site, which consists of several city blocks along Evergreen Avenue (see Figure 2) (Ref. 2, p. 2). Current operations include non-ferrous scrap processing of copper, brass, aluminum, lead, and stainless steel, as well as ferrous scrap processing and storage of new steel and pipe (Ref. 6, p. 2). Over the years, the scrap yard expanded to the east and south and now encompasses approximately 18 acres, including parcels leased to Berman Bros, Inc. by the Jacksonville Seaport Authority (see Figure 3) (Refs. 6, 7).

2.2 ENVIRONMENTAL SETTING

The Jacksonville area is characterized by minimal topographic relief with elevations ranging from mean sea level (msl) at the St. Johns River to 25 feet above msl to the west. The site elevation is approximately 20 feet above msl (Ref. 1). The tidal St. Johns River is located 1.2 miles to the north and east. The St. Johns River flows north, and then east for approximately 15 miles before entering the Atlantic Ocean

(Ref. 1). According to previous investigations, storm water runoff travels generally from the northwestern to southeastern portion of the site, and then travels east to a nearby drainage ditch that becomes Bigalow Creek (Refs. 2; 6, p. 1). Residential areas exist to the immediate east and south (Refs. 1, 7).

The climate in Jacksonville is characterized by mild winters and warm summers. Weather records from the Southeast Regional Climate Center report the average annual temperature as 68.7 °F. January is the coldest month, averaging 53.8 °F, and July is the warmest, averaging 82.4° F (Ref. 8). Rainfall averages 52.39 inches per year (Ref. 8). The mean annual lake evaporation in the area is 45 inches, yielding an annual net precipitation of 6.3 inches (Ref. 9, p. 4). The 2-year 24-hour rainfall event for the area is approximately 5 inches (Ref. 10, p. 95).

2.2.1 Regional Geology and Hydrogeology

The Jacksonville area is located in the Coastal Lowlands region of the Coastal Plain physiographic province of Florida. The Coastal Lowlands region ranges in elevation from sea level to about 100 feet above msl (Ref. 11, pp. D-6, D-7, D-8). The Coastal Plain consists of consolidated and unconsolidated geologic units that slope and thicken seaward from the fall line (Ref. 12, pp. B-10, B-11). The terrain in the Costal Lowlands region is characterized by barrier islands, marshes, and level plains, as well as a series of five terraces formed during the most recent transgressions and regressions of the ocean.

Geologic units that underlie the area, in descending stratigraphic order, include the following: post-Miocene deposits; the Hawthorn Group (consisting of the Coosawhatchee, Marks Head, and Penney Farms Formations); the Ocala Group; and, the Avon Park, Oldsmar, and Cedar Keys Formations (Refs. 12, p. B-58; 13, p. 19). Post-Miocene deposits consist of a basal sequence overlain by alluvial and terrace deposits. About 100 feet thick, these deposits consist of sand, gravel, clay, shells, limestone, and marl (Ref. 12, p. B-38). The Coosawhatchee Formation of the Hawthorn Group consists of quartz sands, dolostone, and clays (Ref. 13, p. 41). The Marks Head Formation of the Hawthorn Group consists of interbedded sands, clays, and dolostone. The Penney Farms Formation of the Hawthorn Group consists of carbonated units with interbedded sand and clays (Ref. 13, p. 34). The thickness of the Hawthorn Group in the Jacksonville Basin is greater than 500 feet (Ref. 13, p. 15).

The Ocala Group can be divided into two parts based on lithology: the upper part is coarse-grained limestone, and the lower is fine-grained, soft limestone (Ref. 12, p. B-30). The total thickness of the

Ocala Limestone in the Jacksonville area is approximately 400 feet (Ref. 12, Plates 2 and 9). The Avon Park Formation consists of locally micritic, pelletal limestone and is approximately 800 feet thick (Ref. 12, B-26). The Oldsmar Formation consists of micritic to finely pelletal limestone, interbedded with fine to medium crystalline, commonly vuggy dolomite, and is approximately 400 feet thick (Ref. 12, p. B-22). The Cedar Keys Formation can also be divided into two parts based on lithology: the upper part is coarsely crystalline dolomite that is moderately to highly porous and the lower is finely crystalline to microcrystalline dolomite interbedded with anhydrite. The thick anhydrite beds form the lower confining unit of the Floridan aquifer (Ref. 12, pp. B-18, B-19). The Cedar Keys Formation is approximately 500 feet thick in the Jacksonville area (Ref. 12, p. B-58).

The two major sources of groundwater in the Jacksonville area are the surficial aquifer and the underlying Floridan aquifer system (Ref. 12, p. B-40). The surficial aquifer is separated from the Floridan aquifer system by the confining beds of the Hawthorn Formation. The surficial aquifer is in the permeable units of the post-Miocene deposits, and groundwater in it is generally under unconfined conditions (Ref. 11, p. D-18). The water level in the surficial aquifer fluctuates seasonally, corresponding to variations in precipitation. The elevation of the water table is estimated to be at or slightly above sea level in the Jacksonville area. Groundwater flow direction of the surficial aquifer in the area is primarily to the east, toward the St. Johns River. The surficial aquifer is recharged primarily by precipitation and is generally hydrologically interconnected with water from lakes, streams, and marshes (Ref. 11, p. D-18). In the Jacksonville area, the elevation of the potentiometric surface of the Floridan aquifer system is higher than the elevation of the water table. As a result, the surficial aquifer may also be recharged by upward leakage from the Floridan aquifer system (Ref. 11, p. D-18).

The northern Floridan aquifer system consists of permeable units of the Suwannee Limestone; Ocala Group; and Avon Park, Oldsmar, and Cedar Keys Formations (Ref. 14, p. 20). In the Jacksonville area, the top of the Floridan aquifer system ranges from approximately 400–550 feet below ground surface (bgs), and the thickness ranges from 1,800–2,200 feet (Ref. 14, pp. 68, 73). Regional groundwater flow direction in the Floridan aquifer is toward the east, but is locally dependent on municipal well locations (Ref. 14, p. 50). In northeastern Florida, the Floridan aquifer system is divided into the Upper and Lower Floridan aquifers (Ref. 11, p. D-17). Low permeability beds in the basal part of the Ocala Group and the upper part of the Avon Park Formation comprise the middle semi-confining unit that separates the two aquifers (Ref. 11, p. D-22). Groundwater in the Floridan aquifer system occurs in joints, faults, bedding planes, and other secondary porosity openings. These openings can become enlarged in carbonate rocks through solution by circulating groundwater (Ref. 11, p. D-25). Therefore, karstic groundwater flow can

occur in the Floridan aquifer. However, the thickness of the Hawthorn Group in the Jacksonville area has prevented the development of sinkholes there (Refs. 1; 14, p. 33).

The Fernandina permeable zone, a high-permeability unit of subregional extent, occurs at the base of the Lower Floridan aquifer in the Jacksonville area (Ref. 12, p. B-70). The Fernandina permeable zone in the Jacksonville area occurs within the permeable units in the Cedar Keys Formation at a depth of about 2,200 feet (Ref. 12, pp. B-26, B-38). This zone is confined above by low-permeability beds in the lowermost Avon Park Formation and below by low-permeability beds in the Cedar Keys Formation (Ref. 12, p. B-58). Groundwater in the uppermost part of the Fernandina permeable zone is fresh; however, groundwater with high salinity occurs throughout the rest of the zone (Ref. 12, p. B-58). Upward migration of saline water from the Fernandina permeable zone into the shallower permeable zones in the Floridan aquifer system has occurred in the Jacksonville area in response to heavy pumping of the Upper Floridan aquifer. Near-vertical faults in the area act as conduits that allow migration of groundwater from the Fernandina permeable zone to the Upper Floridan aquifer (Ref. 12, B-71).

Water recharges the Floridan aquifer system three ways: (1) through breaches in the confining layers caused by sinkholes, (2) by downward leakage where the confining layers are thin or absent, and (3) by direct entry where the aquifer system is exposed at the surface. The principal recharge areas of the Floridan aquifer system near Jacksonville occur to the south and west in portions of western Putnam and Clay Counties and eastern Alachua and Bradford Counties (Ref. 14, pp. 84, 85). These recharge areas occur well outside of the 4-mile study area.

2.3 SITE OPERATIONS AND REGULATORY HISTORY

FSC operated at this location from 1940 until at least 1946, when the site became Albright and Company Junk. In 1965, the scrap metal processor Berman Bros, Inc., obtained ownership of the site and continues to operate at this location (Refs. 2, p. 2; 6; 15). Current site operations include non-ferrous scrap processing of copper, brass, aluminum, lead, and stainless steel, as well as ferrous scrap processing and storage of new steel and pipe (Ref. 2, p. 3). Structures on site include an office building, crane building, warehouse, shear house, metal shredder, and piles of scrap metal (Ref. 2, p. 2). A furnace previously existed on site; however, smelting activities no longer occur on site.

FSC was identified as one of several Florida facilities that previously conducted secondary lead smelting (Ref. 2, p. 2). The secondary smelting process recovered lead metal and alloys from various forms of

scrap metal using a reverberatory blast furnace. FSC reportedly used old automotive batteries as the primary lead feedstock (Ref. 2, p. 3). Studies at other lead smelting sites indicate that lead concentrations in surface soils may exceed 1 percent near the smelters or furnaces (Ref. 2, p. 3). As part of the refining process, some smelting operations introduced antimony, arsenic, and cadmium for a desired product (Ref. 2, p. 2). Waste storage and disposal practices during smelting operations are unknown.

In March 1985, the Florida Department of Environmental Regulation (FDER) inspected the facility and identified the presence of electrical transformers containing polychlorinated biphenyl (PCB) oil that had leaked onto the ground (Ref. 16). Subsequently, a Warning Notice issued to Berman Bros, Inc. in April 1985 stated that inspectors noted "substantial amounts of waste oil had been discharged to the soil and probably to the groundwater beneath your property" (Ref. 17). The Warning Notice required immediate removal of contaminated soil by a qualified contractor and determination of the extent of soil and groundwater contamination (Ref. 17).

In July 1991, Berman Bros, Inc. entered into a Consent Order with FDER to address contamination only where transformers were received and dismantled (Ref. 2, p. 4). Numerous removal actions reportedly occurred to address soil and groundwater contamination (summarized in Section 2.5).

Subsequent FDEP attempts to acquire specific, contaminated soil disposal information were unsuccessful because Berman Bros, Inc. claimed the documentation was accidentally destroyed. The FDEP Northeast District Office subsequently closed the case sometime after 2001 (Ref. 18).

FSC Berman was identified in a 2001 study of former lead smelting facilities that was published in the *American Journal of Public Health* and reported by ABC News. The study identified approximately 430 former lead smelting sites that may contain potentially hazardous soil lead levels and are "unrecognized in the United States" (Refs. 3, 4). Limited sampling for metals contamination has occurred on site.

In February 2002, a tanker car was delivered to the scrap yard that was manifested as clean. As the tanker was cut for scrap, approximately 400 gallons of "black liquor" spilled onto the ground. Black liquor is a by-product of the papermaking process and consists primarily of carbon, sodium, sulfur, oxygen, and potassium (Ref. 19). An environmental cleanup contractor, Mirand Environmental, reportedly cleaned up the spill and notified FDEP the following week (Ref. 2, p. 9). No further details were identified.

2.4 PREVIOUS RELEASES AND INVESTIGATIONS

From 1991–2002, FDEP monitored assessment and remediation activities at the transformer storage area where several removals of contaminated soil and groundwater sampling events were reported to have occurred (Ref. 2, pp. 4–9). The investigations and removal reports were summarized in the 2002 Preliminary Assessment (PA). These sampling events conducted during remedial actions focused on PCB and total petroleum hydrocarbon (TPH) analyses. PCB and metals contamination were documented in on-site soils and groundwater. A summary of these investigations is provided below.

The 1992 Preliminary Contamination Assessment Report (PCAR) documented "detectable levels" of PCBs and lead in soil and shallow groundwater (12 feet bgs) (Ref. 2, pp. 4, 10, 11). More than 2 feet of unspecified oil product was identified in monitoring well MW-2 (see Figure 4). Lead was detected in all four monitoring wells (MW-1 through -4) ranging from 65–525 micrograms per liter (µg/L). PCBs were detected in two wells at concentrations of 5 and 10 µg/L. A composite soil sample was collected from each well boring during well installation. Soil samples contained barium at all four locations [ranging from 1.08–5.14 milligrams per kilogram (mg/kg)]. Lead was identified in three locations (2.9–40.8 mg/kg), chromium in one (1.16 mg/kg), and PCBs in two (3–5 mg/kg). The highest lead concentration was identified in the soil sample closest to the furnace (MW-3 boring) (Ref. 2, p. 10). A follow-up groundwater sampling event one month later did not identify any lead or PCBs above detection limits (Ref. 2, p. 11).

A soil sample collected in June 1992 just above the water table near monitoring well MW-2 contained several polynuclear aromatic hydrocarbons (PAHs) and PCB-1248 (8 mg/kg) (Ref 2, p. 11).

A 1993 Initial Remedial Action report stated that 3,000 gallons of contaminated groundwater and 150 gallons of free product (hydraulic fluid/lubricating oil) were collected from the site and about 450 tons of contaminated soil was excavated and sent to Recycling Alternatives, Inc. in Adel, Georgia for incineration (Ref. 2, p. 5).

A 1994 Contamination Assessment Report (CAR) detailed the installation and sampling of three additional shallow [17 feet below land surface (bls)] monitoring wells (MW-5–7) and one deep (35 feet bls) well (MW-8). Seven wells were sampled in November 1993; well MW-2 was not sampled because of the presence of free product (oil). PCB-1242 (250 µg/L) and -1260 (11 µg/L) were identified in well MW-4. No metals analysis was performed. A February 1994 re-sampling of this well collected filtered

(45 microns) and unfiltered samples for PCB analysis. No PCBs were identified in the filtered sample; the unfiltered sample contained PCB-1242 (200 µg/L) and PCB-1260 (8.2 µg/L) (Ref. 2, p. 12). The CAR also stated that 595 tons of contaminated soil was sent to the Roswell Asphalt Co. in Kingsland, Georgia, for use in the asphalt manufacturing process (Ref. 2, p. 5).

Additional soil sampling events in 1994, 1995, and 1997 delineated PCB-contaminated soil. In 1998, Berman Bros, Inc. informed FDEP that more than 900 tons of PCB-contaminated soil had been excavated from the site and sent to Kedesh, Inc. Soil Recycling (Kedesh) in Screven, Georgia, for disposal (Ref. 2, p. 7). Following a dispute about reported PCBs in the material used to backfill the excavation, Berman Bros, Inc. was required to perform additional assessment and delineation activities.

In October 2000, an additional 435 tons of PCB-contaminated soil was reportedly excavated and sent to Kedesh (Ref. 2, p. 15). Confirmation soil sampling in November 2000 identified several samples exceeding Florida's residential Soil Cleanup Target Levels. Follow-up soil sampling from the same locations in February 2001 did not identify PCB contamination (Ref. 2, p. 15). Groundwater samples collected in November 2000 did not contain PCBs above the minimum detection limit (Ref. 2, p. 15). No information regarding well abandonment was identified.

2.5 POTENTIAL SOURCE AREAS

Previous PCB sources (transformers and contaminated soils) were reportedly removed from the site; however, PCB contamination remains. Current on-site activities include metal recycling (sorting). Either current site activities or previous smelting activities could result in lead contamination, which remains in surface soils surrounding the former furnace. Section 4.0 details the analytical results from samples collected on site.

3.0 SITE INSPECTION ACTIVITIES

This section outlines the observations and activities preformed at FSC Berman during the field sampling event that TN&A conducted the week of June 13, 2005 (Ref. 15). Individual subsections address the sampling investigation and rationales for specific SI activities. The sampling event was conducted in accordance with the EPA-approved *Site Sampling Plan – Revision 4*, dated June 9, 2005.

3.1 SITE CONDITIONS

The site is located immediately south of Alternate US Route 1, between a small rail yard and residential area to the east (Ref. 15, p. 2). Homes are located directly across Evergreen Avenue. Access to the site from the east is restricted by fencing and buildings, with several gates permitting access. The site appears to be completely accessible from the west, along the railroad tracks. The site remains active as a metal recycling facility. Numerous stockpiles of scrap metal were observed, and heavy equipment was staging metal scrap. Vehicles were observed delivering loads of scrap metal. Approximately seven cars were observed in the office parking lot (Ref. 15, p. 2).

3.2 SAMPLE COLLECTION METHODOLOGY AND PROCEDURES

STAT personnel collected 20 surface soil samples, 4 subsurface soil samples, and 3 sediment samples during the week of June 13, 2005 (Ref. 15). Sampling locations are illustrated in Figure 5, and are summarized in Tables 1–3. Table 4 illustrates sample analytical methodology, containers, and preservatives. All sample collection activities and procedures were performed in accordance with the November 2001 EPA Region 4, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (EISOPQAM). Additional quality assurance/quality control samples such as trip, rinsate and preservative blanks, duplicates (two surface soil and one sediment), and matrix spike/matrix spike duplicate samples were collected as required by the EISOPQAM. All glassware was "Quality Certified" and included a certificate of compliance.

Surface soil samples were collected from ground surface to 4 inches bgs using stainless-steel spoons and bowls. Soil was placed into the bowls from the ground and homogenized. Portions of soil for the volatile organic compound (VOC) analysis were collected from the ground and placed directly into the sample jars with zero headspace. TN&A collected subsurface soil samples from the vadose zone (saturated soil above the water table) at three on-site locations and one from the background location. Borings were advanced until saturated soil was encountered, then the auger bucket was replaced and each sample was collected from a clean stainless-steel auger bucket. Samples were homogenized in clean stainless-steel or glass bowls and placed into appropriate containers with stainless-steel spoons. VOC samples were removed from the auger and placed directly into sample containers. TN&A collected three sediment samples (plus one duplicate) from the surface water drainage route to the east. Sediment samples were collected from ground surface to 4 inches bgs using stainless-steel spoons, in the same manner as surface

soil samples. Groundwater samples were not collected as only one groundwater well (upgradient well) remains on site (Ref. 15, p. 3). Seven wells previously existed on site.

Samples collected from the Berman Bros, Inc. property were split with Mr. Paul Layman, a consultant representing Berman Bros. (Ref. 15). During Mr. Layman's brief absence on June 13, 2005, Mr. Richard Springer, owner of A.S.A.P. Water Sampling, collected split samples for Berman Bros, Inc. Samples collected from the Jacksonville Seaport property were split with Mr. Jason Sheasley, P.G., C.H.M.M, from Kimley-Horn and Associates, Inc. The samples were collected by TN&A and relinquished to the consultants under proper chain-of-custody procedures. The laboratory analyses for these samples were performed by a third-party selected by the consultants and were not released to TN&A.

3.3 BACKGROUND SAMPLES

The background surface and subsurface soil samples (FB-01-SS and -01-SB) were collected approximately 200 feet north of the site in a location believed to be characteristic of undisturbed soil in the area unaffected by site activities. A background sediment sample was not collected as the drainage ditch originated on site.

3.4 ANALYTICAL SUPPORT AND METHODOLOGY

All samples collected during the SI were processed and tracked using the *FORMS II Lite* sample tracking software. EPA selected the analytical service providers (laboratories) through the Contract Laboratory Program (CLP). CLP laboratories analyzed all soil and sediment samples for EPA Target Compound List (TCL) VOCs, extractable semi-volatile organic compounds (SVOCs), pesticides and PCBs, and Target Analyte List metals and cyanide.

The labs submitted all analytical data to EPA Region 4 Science and Ecosystems Support Division (SESD) for analytical validation and compliance with CLP terms. Validated data results for this report were then issued to TN&A. Analytical data sheets are provided on CD ROM in Appendix E.

3.5 ANALYTICAL DATA QUALITY AND DATA QUALIFIERS

All analytical data are subject to a quality assurance (QA) review, as described in the EPA SESD laboratory data evaluation guidelines. In the text and analytical data tables in this SI report, some

concentrations of organic and inorganic parameters are qualified with a "J." A "J" qualifier indicates that the qualitative analysis is acceptable; although the quantitative value is only estimated. Other compounds are qualified with an "N," indicating detection on presumptive evidence of their presence. This means that compound identification is only tentative; presumptive detection cannot be considered a positive indication of its presence. Results of some sample analyses are qualified with a "U," meaning that the constituent was analyzed for, but undetected. The reported number is the laboratory-derived minimum quantitation limit (MQL) for the constituent in that sample. Sample results qualified with an "R" indicate the data were rejected and unusable. Because these constituents are not routinely analyzed for or reported, background concentrations or MQLs are generally unavailable for comparison.

4.0 SOURCE SAMPLING

This section discusses the sources evaluated at the site, and details the sampling locations and analytical results from samples collected therein. Based on sampling results, the source of contamination is considered to be approximately 6.5 acres of contaminated soil containing elevated levels of lead and PCBs resulting from past activities on site. Smelting activities have ceased and the furnace no longer exists; however, the site remains active as a metal recycling facility.

4.1 SOURCE SAMPLE LOCATIONS

Twenty surface soil samples and four subsurface soil samples were collected from on-site soils surrounding the former furnace. Three sediment samples were collected from the drainage ditch (Bigalow Creek), to the east of the site. Soil and sediment sampling locations are illustrated in Figure 5 and described in Tables 1–3. Photographs of sampling locations are provided in Appendix C.

4.2 SOURCE ANALYTICAL RESULTS

Analytical result summaries for soil and sediment samples are provided in Tables 5–7 located at the end of the report. HRS-elevated concentrations are shaded. HRS-elevated concentrations are concentrations identified at or above three times the background concentration, or concentrations in excess of the detection limit of a non-detect background result. For secondary comparison purposes for surface and subsurface soil, EPA Region 9 Preliminary Remediation Goals (PRGs) for industrial soil are included in the right-hand column (Ref. 20). PRG values are generic risk-based concentrations for evaluating

contaminated sites. For comparison purposes of sediment samples, EPA Region 4 Waste Management Division Sediment Screening Values (SSVs) were included (Ref. 21). Sample concentrations exceeding any one of these guidance values are shown in bold. Analytical data sheets listing all results are located in Appendix E.

Analytical results revealed several contaminants at elevated concentrations in on-site surface and subsurface soils as well as sediment samples collected from the drainage ditch leading to Bigalow Creek. The contaminants most attributable to past site activities were PCBs and lead. PCBs were also the main focus of previous investigations at the site.

PCB-1242 (Aroclor 1242), PCB-1254 (Aroclor 1254), and PCB-1260 (Arclor 1260) were detected at elevated concentrations in five surface soil locations including -SS-02, -SS-03, -SS-04, and -SS-05, located around the former furnace, and -SS-14, located 400 feet south of the former furnace. The detections were also above the PRG value of 740 micrograms per kilogram (μg/kg). In addition to the abovementioned locations, 13 surface soil locations contained elevated concentrations of PCB-1242, PCB-1254, and/or PCB-1260. The highest detection of PCB-1242 (9,200 μg/kg) was detected in surface soil sample -SS-05, located approximately 50 feet south of the former furnace. The highest detection of PCB-1254 (6,500 μg/kg) was detected in surface soil sample -SS-06, located approximately 200 feet northeast of the former furnace. The highest detection of PCB-1260 (6,800 μg/kg) was detected in surface soil sample -SS-07, located approximately 200 feet southwest of the former furnace. Several additional PCBs were detected at elevated concentrations in surface soil samples; however, all concentrations were below their respective PRG values.

Dieldrin was detected at an elevated concentration in one subsurface soil sample, -SB-02. PCB-1254 was also detected in one subsurface sample, -SB-03, at an elevated concentration. Neither PCB was detected above PRG values. PCB-1260 was present above its SSV value of 33 μg/kg in all sediment samples; particularly sample -SD-01 (2,300 μg/kg), located in the surface water runoff route leaving the site. PCB-1254 was also detected in -SD-01 at 1,800 μg/kg.

Nine surface soil samples contained at least 11 metals at elevated concentrations. Five of these locations, collected in close proximity to the former furnace, contained at least 17 metals at elevated concentrations. The highest concentration of lead was detected in surface soil sample -SS-06 at 2,000 mg/kg. -SS-06 was collected approximately 200 feet northwest of the former furnace. Lead was detected in seven samples above the PRG of 800 mg/kg. In addition to lead, several metals including arsenic, chromium, and iron

were detected in at least one surface soil sample above its respective PRG value. Several metals were detected at elevated concentrations in subsurface soil sample -SB-04, collected in the same location as surface soil sample -SS-16, approximately 700 feet south-southwest of the former furnace. All metals, except arsenic (2.3 mg/kg), were below their respective PRG values. Eight metals including arsenic, cadmium, chromium, nickel, lead, zinc, mercury, and copper were detected at elevated levels in sediment sample -SD-01, located in the surface water runoff route (drainage ditch) leaving the site. Six of the abovementioned metals were also detected in sediment sample -SD-03, located several hundred feet downgradient from the origin of the drainage ditch. Lead was detected in -SD-01 at 920 mg/kg and in -SD-03 at 400 mg/kg. Both concentrations are above the SSV of 124 mg/kg for lead.

VOCs were not detected in surface and/or subsurface soil samples. VOCs were not detected above SSVs in any sediment sample collected from the drainage ditch.

Several SVOCs were detected at elevated concentrations in surface soils. Phenanthrene was detected at elevated concentrations in 11 surface soil locations, with the highest detection at 3,500 µg/kg in -SS-05, located approximately 50 feet south of the former furnace. Bis(2-ethylhexyl)phthalate was detected at elevated concentrations in nine surface soil locations, with the highest detection at 13,000 µg/kg in -SS-02 and -SS-05. FB-02-SS is located approximately 50 feet west of the former furnace. A PRG value was not established for phenanthrene; however, bis(2-ethylhexyl)phthalate was not detected above its PRG values of 120,000 µg/kg. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene were detected in at least one surface soil sample above PRG values. SVOCs were not detected at elevated concentrations in subsurface soils. Several SVOCs were detected above SSVs in -SD-01, located in the surface water runoff route (drainage ditch) leaving the site. SVOCs were not considered site-attributable .

4.3 SOURCE CONCLUSIONS

Despite several HRS-elevated contaminants identified on site, only lead, PCB-1242, PCB-1254, and PCB-1260 are considered site-attributable (resulting from past site activities). All other HRS-elevated compounds were not considered site-attributable. Lead, PCB-1242, PCB-1254, and PCB-1260 remain in contaminated surface soils and sediment samples collected on site and in the drainage ditch that becomes Bigalow Creek.

5.0 PATHWAYS

This section discusses the groundwater migration, surface water migration, soil exposure, and air migration pathways associated with an HRS evaluation, the targets associated with each pathway, and pathway-specific conclusions. Sampling locations and analytical results for samples collected from the specific pathways are also discussed.

5.1 GROUNDWATER MIGRATION PATHWAY

The groundwater migration pathway is a potential concern because all potable water in the study area is from groundwater sources. All community water systems draw water from the Floridan aquifer. The deep, confined, artesian characteristics of the Floridan aquifer reduce the likelihood of site contamination migrating into the aquifer. Private wells may also exist in the study area; however, none have been identified. Regional geology and municipal/community well systems was discussed in Section 2.2.

The Jacksonville Electric Authority (JEA) provides the majority of municipal water in Jacksonville via a system of 33 water treatment plants utilizing approximately 100 artesian wells developed into the Floridan aquifer (Refs. 22, 23). The 33 plants are divided into the North Grid and South Grid, with 10 plants providing water to an estimated population of 420,989 in the North Grid, and 23 plants providing water to an estimated 396,461 people in the South Grid (Ref. 24). Several additional independent water plants have also been acquired by JEA. Prior to 2002, United Water of Florida (UWF) operated several smaller municipal/community water treatment plants in Jacksonville. In December 2001, UWF sold its regulated properties to JEA and formed a "public-private partnership" (Ref. 23).

Forty eight municipal/community wells from ten different water treatment plants were determined to be within a 4-mile radius of site (Refs. 1, 24). Table 1 lists the water systems and apportioned target populations located in the Floridan aquifer (Refs. 1, 24–27). The following JEA water plants were identified within 4 miles of site: North Grid - Main St (9 wells), McDuff (8 wells), and Norwood (4 wells); South Grid – River Oaks (7 wells), Hendricks (5 wells), Arlington (4 wells), and Lake Lucina (3 wells) (Refs. 22–25). The North Grid includes 47 wells from 10 water plants and serve a total of 420,989 people, averaging 8,957 people per well. The South Grid includes 45 wells from 23 plants and serve a total of 396,461 people, averaging 8,810 people per well (Refs. 24, 25).

Additional independent JEA or historical UWF water plants were also identified within 4 miles of site including Woodmere, Lake Forrest, Magnolia Gardens and the Jacksonville University. The Woodmere system contains 3 wells and serve a total of 4,565 people, averaging 1,522 people per well. Lake Forrest and Magnolia Gardens have one well each serving 840 connections and 701 connections respectively (Refs. 24, 26). When multiplied by the average number of persons per household (2.51), Lake Forrest serves is 2,108 people and Magnolia Gardens serves 1,760 people (Refs. 24, 27). The Jacksonville University system contains 3 wells that serve 848 people, averaging 283 people per well (Refs. 24, 25).

5.2 SURFACE WATER MIGRATION PATHWAY

The surface water migration pathway is a significant concern at FSC Berman because of observed releases of site-attributable substances to sediments in the drainage ditch leading to Bigalow Creek. Based on a review of the topographic map and site observations, the Probable Point of Entry (PPE) is the drainage ditch leading to Bigalow Creek (Ref. 1). This drainage ditch conveys surface water from the site and surrounding areas, joins the discharge water of the Buchman Street Wastewater treatment facility, and emptys into the St. Johns River (Ref. 6, p. 9). The St. Johns River travels north, and then east, about 15 miles where it discharges into the Atlantic Ocean. The 15-mile Target Distance Limit (TDL) terminates within the St. Johns River just before entering the Atlantic Ocean (Ref. 1). The St. Johns River is a large fishery and recreational surface water body (Ref. 28). The river provides designated critical habitat for the federally endangered West Indian manatee, and several miles of wetland areas exist in the more distant portions of the 15-mile TDL near the Atlantic Ocean (Refs. 29, 30, 31). Threatened and endangered species living in the St. Johns estuary include bald eagles, wood storks, and alligators (Ref. 32, p. 34; 33; 34).

The St. Johns River is used for recreational fishing and boating, and the St. Johns and Atlantic Ocean support commercial fishing as well (Ref. 32, pp. 1–19). Popularly fished freshwater species in the area, depending on the season, include bluegill, largemouth and striped bass, shellcrackers, warmouth, crappie, pickerel, scrappy, and shad. Freshwater-saltwater transitional species include tarpon, redfish, speckled trout, cobia, bluefish, drum, flounder, jack crevalle, and bonito (Ref. 32, p. 8). The saltmarshes of the St. Johns estuary are vital nurseries for fish, shrimp, and crab that make up a multi-million dollar fishery (Ref. 32, pp. 23, 24).

The large size, tidal characteristics, and moderate flow rate (3,696 cubic feet per second) of the river prohibit the generation of significant potential contamination target values within the surface water

pathway (Ref. 35). In addition, industrial development along the St. Johns River's shores create attribution issues that complicate its use in scoring the surface water pathway (Refs. 1, 28).

5.3 SOIL EXPOSURE PATHWAY

The soil exposure pathway at FSC Berman is of primary concern because of the large number of nearby residential receptors. A population of 10,790 was determined to live within 1 mile, with 2,482 people within 0.5 mile and 301 people within 0.25 mile (Ref. 36). Smelting activities can emit metal fumes that may be carried by wind currents and deposited on nearby soils (Refs. 4, 37). Although sampling data determined several HRS-elevated analytes in surface soils and sediments, only lead, PCB-1242, PCB-1254, and PCB-1260 are considered to be site-attributable.

5.3.1 Physical Conditions

FSC Berman is located in an industrial area with several buildings, scrap metal piles, and heavy equipment currently on site (Ref. 15). The furnace used in the smelting process is no longer on site. The site is located immediately south of Alternate US Route 1. Railroad tracks exist to the west of the site, lying north to south. Residential areas exist directly across Evergreen Avenue, east of the site. Access to the site from the east is restricted by fencing and buildings, with several gates permitting access. The site is accessible from the west, along the railroad tracks. The site remains active as a metal recycling facility.

5.3.2 Soil Exposure Sample Locations and Analytical Results

All surface soil samples were collected within the top 4 inches and are considered accessible for direct contact. Subsurface soil samples were collected from between 2–3 feet in depth. Sample locations are illustrated in Figure 5 and analytical results are presented in Tables 5–7. On-site surface/subsurface soil and sediment sampling locations and analytical results are discussed in detail in Section 4.0. The on-site HRS-elevated concentrations included detections of several analytes; however, only lead, PCB-1242, PCB-1254, and PCB-1260 were considered to be site attributable.

5.3.3 Soil Targets

Residents are located approximately immediately to the east of FSC Berman. Nearby populations include 301 people within 0.25 mile of site, 2,181people between 0.25 – 0.5 mile, and 8,308 people between 0.5 – 1 mile from site (Ref. 15). An estimated 20 workers are considered to be on site. There are no known terrestrial sensitive environments on site.

5.3.4 Soil Conclusions

Several metals and organic constituents were present at HRS-elevated concentrations in surface and subsurface soil samples at FSC Berman, as well as sediment samples collected from the surface water runoff route leaving the site. Numerous samples (particularly around the former furnace) contained lead, PCB-1242, PCB-1254, and PCB-1260 at elevated levels. PRGs were exceeded in surface soils and SSVs were exceeded in sediment samples.

5.4 AIR MIGRATION PATHWAY

The air migration pathway at FSC Berman was not evaluated since smelting activities no longer occur on site. During smelting activities, the air migration pathway may have contributed or been a source of contamination downwind of the site as metals fumes were transported off site into residential areas. Sampling results from the areas near the edge of site do not indicate significant lead migration occurred.

6.0 SUMMARY AND CONCLUSIONS

FSC Berman was identified in a study of former lead smelting facilities that was published in the *American Journal of Public Health* and reported by ABC News (Refs. 3, 4). The study identified approximately 430 former lead smelting sites that may contain potentially hazardous soil lead levels and are "unrecognized in the United States". The site currently exists in an area with mixed industrial/residential uses. Several buildings, scrap metal piles, and heavy equipment currently exist on site. The former furnace no longer exists on site. Railroad tracks lie directly to the west of the site, running north/south. Alternate US Route 1 borders the site to the north, and Evergreen Avenue borders the site to the east (Ref. 15). Surface water runoff is directed east, to a drainage ditch (Bigalow Creek), which later flows into the St. Johns River.

Twenty surface soil samples and four subsurface soil samples were collected from the approximate location of the former FSC Berman furnace used in the smelting process, as well as surrounding locations in order to delineate potential migration. The background sample was collected from approximately 200 feet north of the site. Three sediment samples were collected from the drainage ditch that originated on site and flowed eastward off site.

Despite several HRS-elevated contaminants identified on site, only lead, PCB-1242, PCB-1254, and PCB-1260 were considered site-attributable (resulting from the lead smelter activities and previous investigations). All other HRS-elevated compounds were not considered a site-attributable as most were detected near roadways and/or railroad tracks.

After an HRS evaluation based on recent analytical results, the site failed to generate an appreciable HRS site score. The score was driven by the groundwater migration pathway, surface water pathway, and soil exposure pathway. Documenting actual contamination of residential properties would increase the site score. Further federal actions or investigations are to be determined by EPA.

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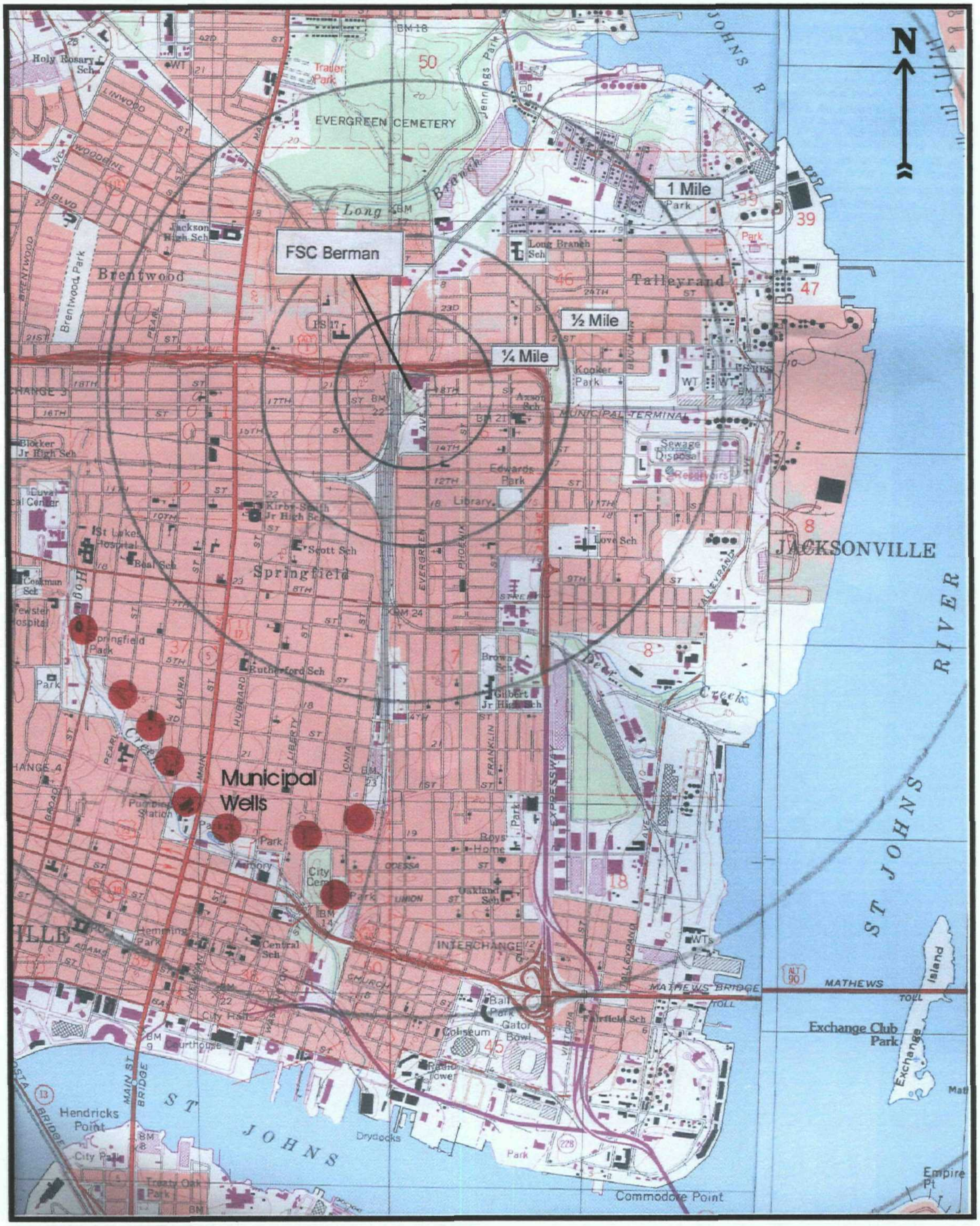


Copied from USGS 7.5-Minute topographic maps of Florida: Jacksonville 1994 and Arlington 1994.

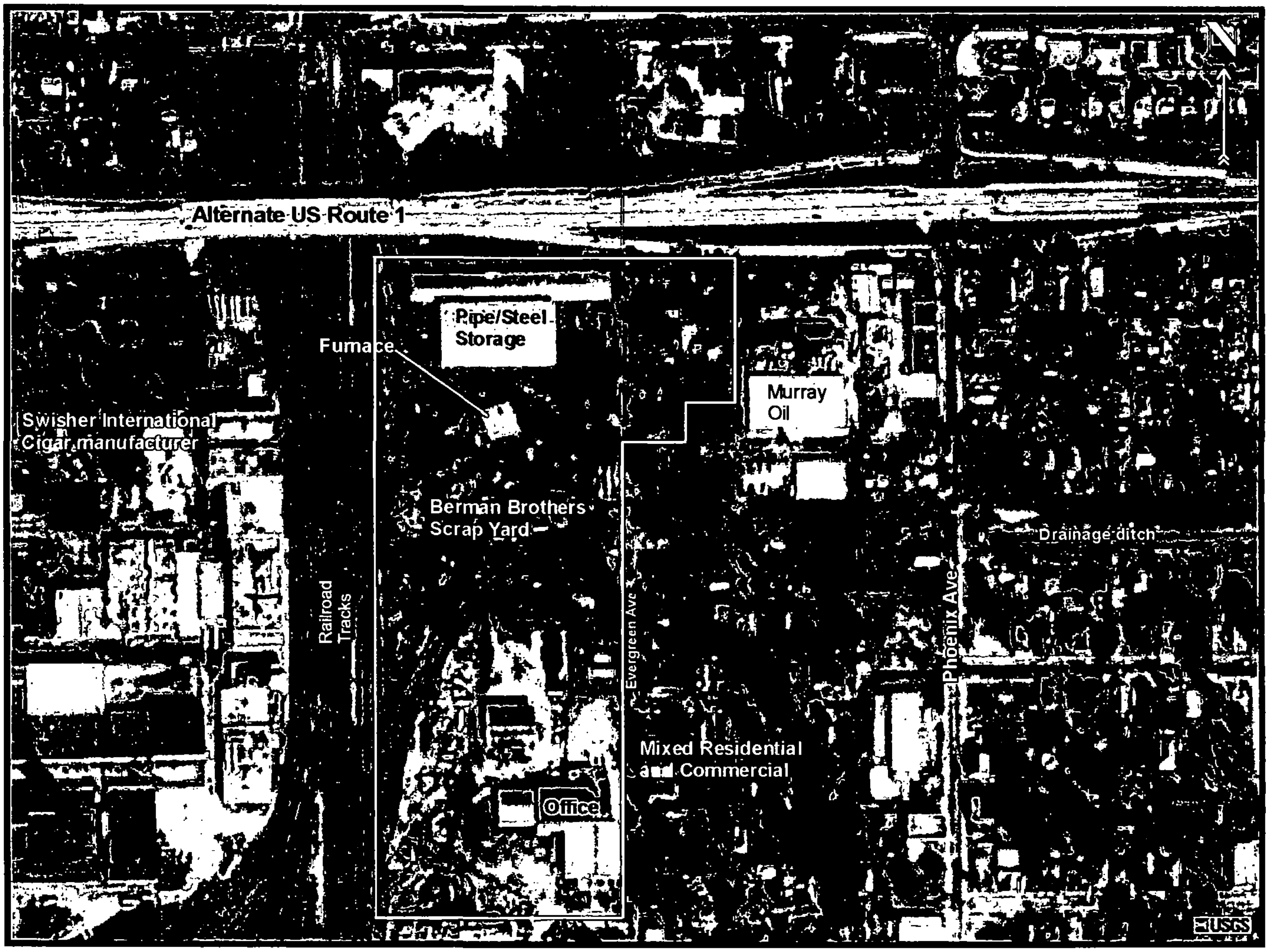
Scale in miles

0 1/4 1/2 1

FLORIDA SMELTING COMPANY
BERMAN BROTHERS SCRAP YARD
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

FIGURE 1 - TOPOGRAPHIC MAP

TN & A T N & Associates, Inc.
Engineering and Science



Aerial photograph dated January 22, 1994, provided by USGS via Terraserver.microsoft.com.
Site features obtained from 1992 Preliminary Contamination Assessment Report.
Property information obtained from the City of Jacksonville Property Appraisers website.

Approximate scale in feet

0 250 500 1000

FLORIDA SMELTING COMPANY
BERMAN BROTHERS SCRAP YARD
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

FIGURE 2 - AERIAL PHOTOGRAPH

T N & Associates, Inc.
Engineering and Science

Aerial photograph and property ownership information obtained from the City of Jacksonville Property Appraisers website.

Scale in feet
0 50 100 200

LEGEND

Property parcel

R/W Right of Way

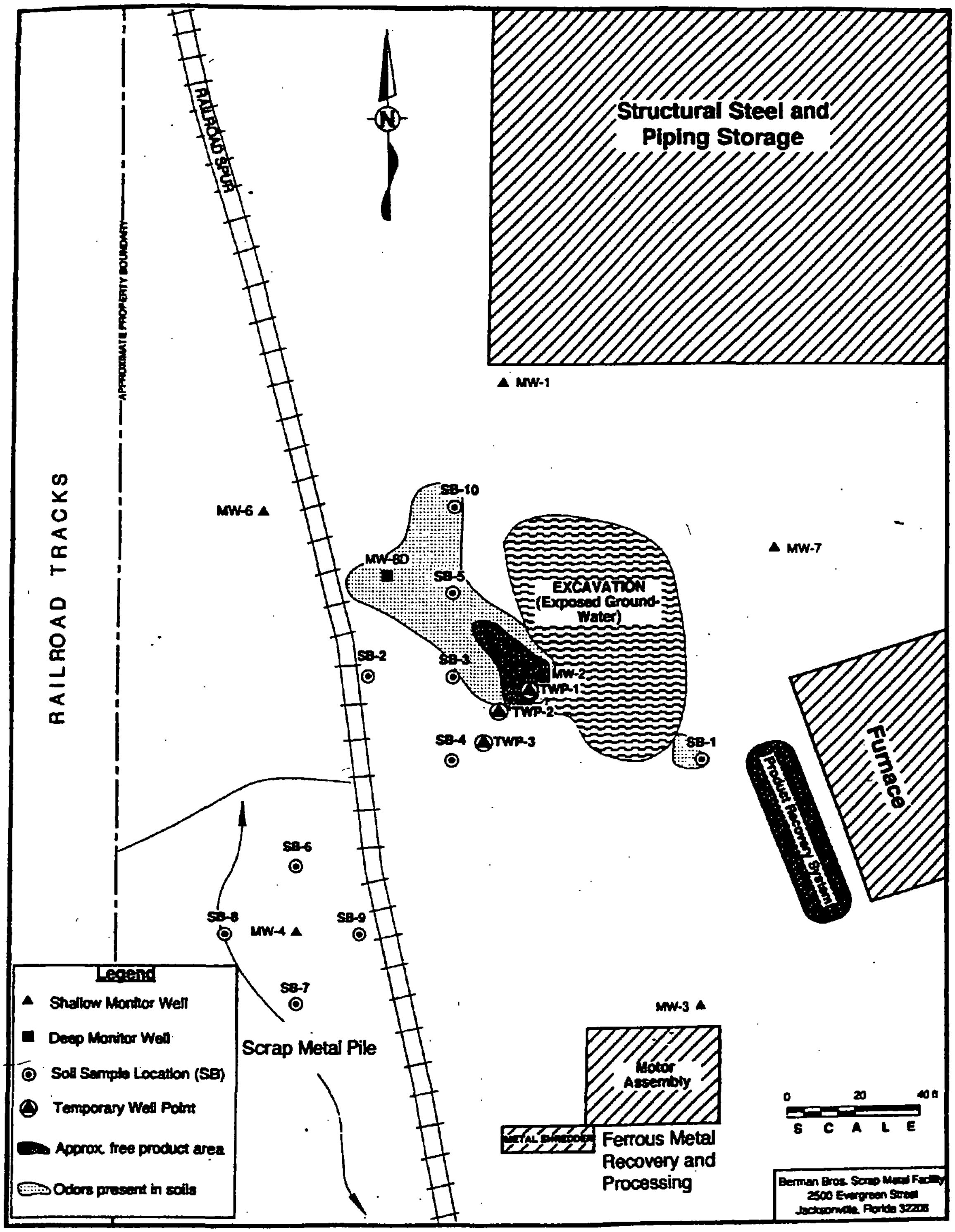
Listed property owner

Streets

FLORIDA SMELTING COMPANY
BERMAN BROTHERS SCRAP YARD
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

FIGURE 3 - AREA PLAT MAP

T N & Associates, Inc.
Engineering and Science

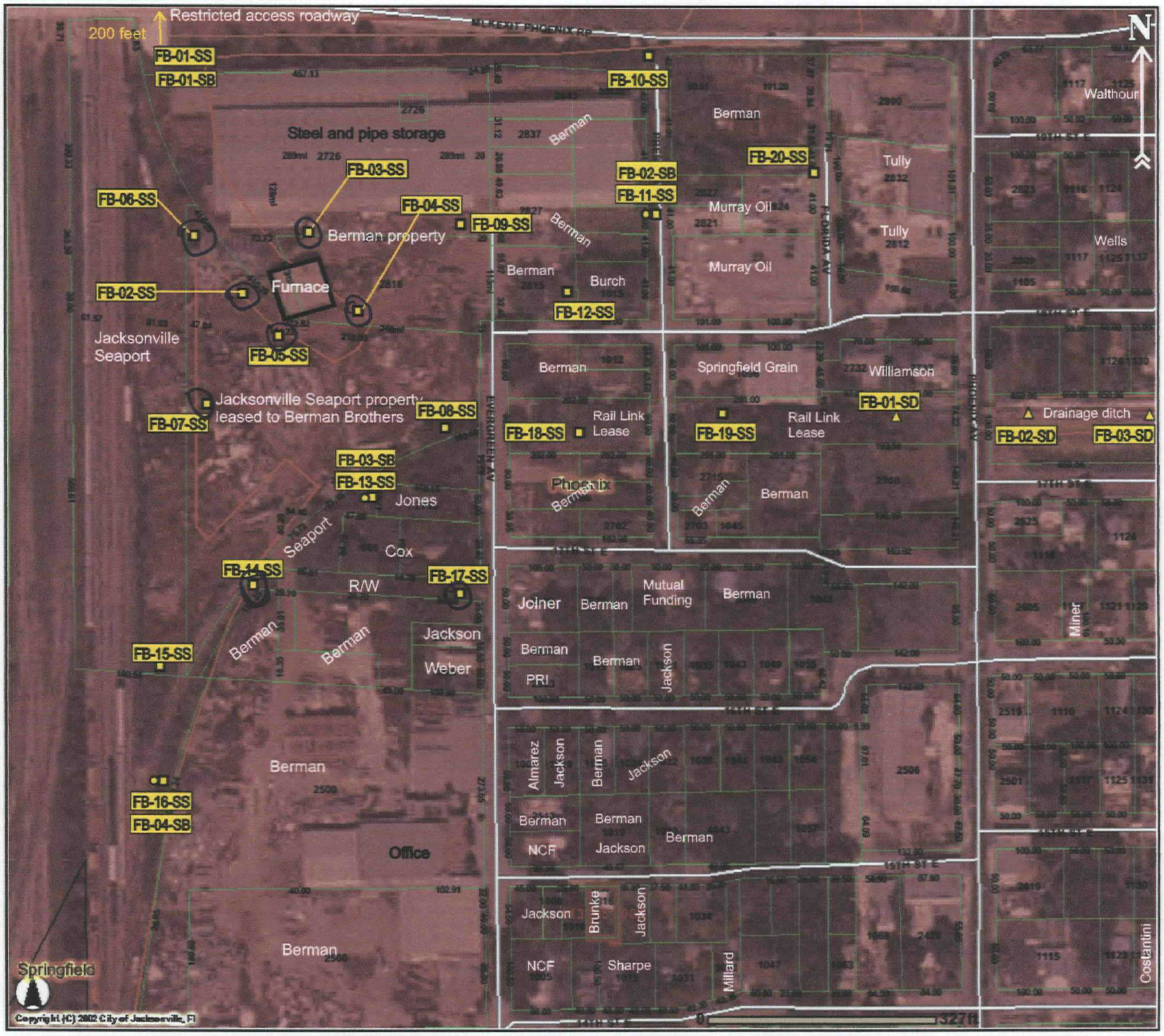


Copied from the 2002 Preliminary Assessment Report.

FLORIDA SMELTING COMPANY
BERMAN BROTHERS SCRAP YARD
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

FIGURE 4 - EXCAVATION AND WELL LOCATION MAP

T N & Associates, Inc.
Engineering and Science



Aerial photograph and property ownership information obtained from the City of Jacksonville Property Appraisers website.
Facility structure locations obtained by 1992 Preliminary Contamination Assessment Report.

LEGEND

- Property parcel
- R/W Right of Way
- Listed property owner
- Streets
- Surface soil sample
- Sediment sample
- Subsurface soil sample

Scale in feet
0 50 100 200

FLORIDA SMELTING COMPANY
BERMAN BROTHERS SCRAP YARD
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

FIGURE 5 - SAMPLING LOCATIONS MAP

T N & Associates, Inc.
Engineering and Science

Appendix B

Tables

TABLE 1
SURFACE SOIL SAMPLING LOCATIONS

Sample Number	Location	Rationale
FB-01-SS	Background; 1,000 feet northwest of site in Duval County R/W	Establish background conditions for comparison to other samples
FB-02-SS	50–100 feet west of furnace	Determine presence or absence of hazardous constituents
FB-03-SS	50–100 feet north of furnace	Determine presence or absence of hazardous constituents
FB-04-SS	50–100 feet east of furnace	Determine presence or absence of hazardous constituents
FB-05-SS	50–100 feet south of furnace	Determine presence or absence of hazardous constituents
FB-06-SS	200 feet northwest of furnace	Determine presence or absence of hazardous constituents
FB-07-SS	200 feet southwest of furnace	Determine presence or absence of hazardous constituents
FB-08-SS	200 feet southeast of furnace	Determine presence or absence of hazardous constituents
FB-09-SS	200 feet northeast of furnace	Determine presence or absence of hazardous constituents
FB-10-SS	500 feet northeast of furnace	Determine presence or absence of hazardous constituents
FB-11-SS	450 feet east-northeast of furnace	Determine presence or absence of hazardous constituents
FB-12-SS	350 feet east of furnace	Determine presence or absence of hazardous constituents
FB-13-SS	300 feet southeast of furnace	Determine presence or absence of hazardous constituents
FB-14-SS	400 feet south of furnace	Determine presence or absence of hazardous constituents
FB-15-SS	500 feet south-southwest of furnace	Determine presence or absence of hazardous constituents
FB-16-SS	700 feet south-southwest of furnace	Determine presence or absence of hazardous constituents
FB-17-SS	450 feet south-southeast of furnace	Determine presence or absence of hazardous constituents
FB-18-SS	350 feet southeast of furnace	Determine presence or absence of hazardous constituents
FB-19-SS	550 feet east-southeast of furnace	Determine presence or absence of hazardous constituents
FB-20-SS	700 feet east-northeast of furnace	Determine presence or absence of hazardous constituents

Notes:
FB Florida Smelting Company/Berman Brothers Scrap Yard
SS Surface soil sample
R/W Right-of-way

TABLE 2
SUBSURFACE SOIL SAMPLING LOCATIONS

Sample Number	Location	Rationale
FB-01-SB	Background; 1,000 feet northwest of site in Duval County R/W	Establish background conditions for comparison to other samples
FB-02-SB	450 feet east-northeast of furnace	Determine presence or absence of hazardous constituents
FB-03-SB	300 feet southeast of furnace	Determine presence or absence of hazardous constituents
FB-04-SB	700 feet south-southwest of furnace	Determine presence or absence of hazardous constituents

Notes: FB Florida Smelting Company/Berman Brothers Scrap Yard
SB Subsurface soil sample
R/W Right-of-way

TABLE 3
SEDIMENT SAMPLING LOCATIONS

Sample Number	Location	Rationale
FB-01-SD	Surface water runoff route leaving site	Determine presence or absence of hazardous constituents
FB-02-SD	Origin of drainage ditch to the east	Determine presence or absence of hazardous constituents
FB-03-SD	Several hundred feet downgradient from the origin of the drainage ditch	Determine presence or absence of hazardous constituents

Notes: No background samples are proposed as the surface water runoff route originates from the site.
FB Florida Smelting Company/Berman Brothers Scrap Yard
SD Sediment sample

TABLE 4
ANALYTICAL METHODOLOGY, SAMPLE CONTAINERS, AND PRESERVATIVES

Matrix	Analysis	EPA Method	Sample Container	Preservative
Soil	VOA	CLP	Two 2-oz glass jars with septum lid	Cool to 4 °C
	BNA/Extractable Pesticides/PCBs	CLP	One 8-oz glass jar	Cool to 4 °C
	Metal CN	CLP	One 8-oz glass jar	Cool to 4 °C
Ground-water and surface water	VOA	CLP	Three 40-ml glass jars with septum lids	HCl to pH < 2, cool to 4 °C
	BNA/Extractable	CLP	Two 1-L amber glass jars	Cool to 4 °C
	Pesticides/PCBs	CLP	Two 1-L amber glass jars	Cool to 4 °C
	Metal	CLP	One 1-L poly jar	HNO_3 to pH < 2, cool to 4 °C
	CN	CLP	One 1-L poly jar	NaOH to pH > 12, cool to 4 °C
Sediment	VOA	CLP	Two 2-oz glass jars with septum lids	Cool to 4 °C
	BNA/Extractable Pesticides/PCBs	CLP	One 8-oz glass jar	Cool to 4 °C
	Metal CN	CLP	One 8-oz glass jar	Cool to 4 °C

Notes:

BNA	Base, neutral, and acid extractables
°C	Degree Celsius
CN	Cyanide
CLP	Contract Laboratory Program
HCL	Hydrochloric acid
HNO_3	Nitric acid
L	Liter
NaOH	Sodium hydroxide
oz	Ounce
PCB	Polychlorinated biphenyl
<	Less than
>	Greater than
VOA	Volatile organic analysis

TABLE 5
SURFACE SOIL SAMPLE RESULTS

Analyte	Back-Ground	On site											Guidance
		Florida Smelting Company/Berman Brothers Scrap Yard											PRG[b]
	FB-SS-01	FB-SS-02	FB-SS-03	FB-SS-04	FB-SS-05	FB-SS-06	FB-SS-22[a]	FB-SS-07	FB-SS-08	FB-SS-09	FB-SS-10	FB-SS-11	
Metals (mg/kg)													
Silver	1.1 U	4.1	8.0	1.9	1.2	3.6	2.5	--	0.30 J	--	--	0.13 J	5,100
Arsenic	**2.1 J**	**8.2 J**	**4.9 J**	**210 J**	**3.6 J**	**17 J**	**8.8 J**	0.91 R	**3.2 J**	--	**1.6 J**	1.5 J	1.6
Barium	22	320	290	300	310	250 J	330 J	21 J	41	190 J	21 J	46 J	67,000
Beryllium	0.07 U	0.42 J	0.40 J	0.37 J	0.66	0.21 J	0.18 J	0.06 J	0.31 J	0.28 J	0.11 J	0.06 J	1,900
Cadmium	0.93	25	18	--	30	25	23	24	4.7	3.7	0.50 J	1.4	450
Cobalt	1.4 UJ	19 J	10 J	23 J	19 J	22 J	18 J	--	--	4.7 J	0.57 J	1.1 J	1,900
Chromium	8.9	440	160	390	**800**	180	180	9.2	13	**650**	6.7	20	450
Copper	710 J	3500 J	3500 J	3300 J	1400 J	990 J	3400 J	40 J	180 J	300 J	37 J	100 J	41,000
Nickel	9.8	330	200	290	460	1300 J	150 J	8.2	14	78 J	5.1 J	9.6 J	20,000
Lead	300	**1900**	**1800**	**1300**	**1100**	**2000 J**	**1400 J**	120	320	240 J	70 J	120 J	800
Antimony	1.5 R	8.6 J	8.7 J	170 J	23 J	2.7 J	7.4 J	1.4 R	2.5 J	--	0.77 J	0.83 R	410
Selenium	3.7 U	16	8.3	--	17	12 J	11 J	--	--	5.3 J	--	--	5,100
Thallium	2.6 U	9.4	3.3	13	9.0	5.7	4.7	--	--	13	--	--	67
Vanadium	6.9	130	59	28	120	96 J	40 J	5.0 J	22	110 J	8.5 J	8.3 J	1,000
Zinc	250 J	5200 J	4400 J	68000 J	3800 J	5700 J	8400 J	200 J	370 J	700 J	590 J	260 J	100,000
Total Mercury	0.08 UJ	3.3	1.3	3.1	4.1	1.6	1.6	--	0.28	0.28	--	0.17	310
Aluminum	2800 J	19000 J	28000 J	12000 J	27000 J	13000 J	11000 J	3500 J	3700 J	7600 J	4700 J	3100 J	100,000
Manganese	60 J	2800 J	990 J	4200 J	2300 J	1400 J	1100 J	57 J	50 J	6700 J	33 J	280 J	19,000
Magnesium	180 J	4900 J	2000 J	4700 J	3600 J	1600 J	1400 J	160 J	200 J	10000 J	260 J	410 J	—
Iron	8100 J	**160000 J**	64000 J	**210000**	**170000 J**	**140000 J**	**130000 J**	11000 J	9600 J	71000 J	3100 J	9900 J	100,000
Volatiles (µg/kg) No Analytes were Detected.													
Semi-volatiles (µg/kg)													
Acenaphthylene	290 J	--	--	--	--	270 J	--	--	--	--	--	--	—
Acenaphthene	350 U	--	250 J	--	--	--	--	--	--	--	--	--	29,000,000
Fluorene	350 U	--	240 J	--	--	--	--	--	--	--	--	--	26,000,000
Phenanthrene	110 J	1400 J	2300	1600 J	3500 J	1600	1200 J	--	--	260 J	--	--	—
Anthracene	320 J	--	630 J	--	--	500 J	--	--	--	--	--	--	100,000,000
Fluoranthene	1100	3200 J	2400	2600	6500	2300	2900 J	--	230 J	540 J	--	210 J	22,000,000
Pyrene	1600 J	4100 J	3000	3400	8500	3800 J	2800 J	--	240 J	660 J	--	220 J	29,000,000
Phenol	350 U	--	--	--	--	--	--	--	--	--	--	--	100,000,000
Benzyl Butyl Phthalate	350 UJ	--	--	--	--	1100 J	--	--	--	--	--	--	100,000,000
bis(2-Ethylhexyl) Phthalate	350 UJ	13000	1800	7500	13000	4400 J	12000 J	--	--	3400 J	--	--	120,000
Benzo(a)Anthracene	780	1800 J	1300	1500 J	**3500 J**	**2100 J**	1700 J	--	140 J	350 J	--	120 J	2,100
Chrysene	1300	2200 J	1400	1800 J	4000 J	2200 J	2100 J	--	150 J	460 J	--	150 J	210,000
Di-n-Octylphthalate	350 UJ	--	--	--	--	930 J	--	--	--	--	--	--	25,000,000
Benzo(b)Fluoranthene	1500	2000 J	1400	1500 J	**3300 J**	2000 J	**2300 J**	--	180 J	510 J	--	150 J	2,100
Benzo(k)Fluoranthene	1100	1800 J	1200	1800 J	3300 J	2000 J	2100 J	--	140 J	540 J	--	170 J	21,000
Benzo-a-Pyrene	**960**	**1800 J**	**1200**	**1500 J**	**3300 J**	**2100 J**	**1700 J**	--	160 J	**410 J**	--	140 J	210
Indeno (1,2,3-cd) Pyrene	930	1800 J	1400	1500 J	**2500 J**	1800 J	1600 J	--	140 J	410 J	--	120 J	2,100
Dibenzo(a,h)Anthracene	**290 J**	--	**230 J**	--	--	**470 J**	--	--	--	--	--	--	210
Benzo(ghi)Perylene	860	1200 J	800 J	1000 J	1300 J	1600 J	1500 J	--	130 J	450 J	--	120 J	—
Dimethyl phthalate	350 U	--	1900	3300	--	--	--	--	--	1100	--	--	100,000,000
Carbazole	100 J	--	340 J	--	--	470 J	--	--	--	--	--	--	86,000
Pesticides/PCBs (µg/kg)													
Aldrin	1.8 U	--	--	--	--	--	--	--	--	--	--	4.2	100
alpha-BHC	1.8 U	15 NJ	--	--	--	--	--	--	--	--	--	--	—
beta-BHC	1.8 U	--	60	52	--	--	--	--	--	5.6 NJ	2.3 J	--	—
Dieldrin	3.5 UJ	--	--	--	--	--	--	--	--	--	--	54 J	110
4,4'-DDE (p,p'-DDE)	4.3 U	--	--	--	--	--	--	--	3.7 J	--	1.5 NJ	4.2 N	7,000

TABLE 5
SURFACE SOIL SAMPLE RESULTS

Analyte	Back-Ground	On site											Guidance
		Florida Smelting Company/Berman Brothers Scrap Yard											PRG[b]
	FB-SS-01	FB-SS-02	FB-SS-03	FB-SS-04	FB-SS-05	FB-SS-06	FB-SS-22[a]	FB-SS-07	FB-SS-08	FB-SS-09	FB-SS-10	FB-SS-11	
4,4'-DDD (p,p'-DDD)	3.5 U	--	--	--	--	--	--	--	--	--	--	--	10,000
Endrin	3.7 U	--	--	--	--	--	--	--	3.7 J	--	--	--	180,000
Endosulfan Sulfate	5.6	--	--	--	--	--	--	--	--	--	--	--	—
PCB-1242 (Aroclor 1242)	35 U	**5800**	**1200 J**	**5400**	**9200**	--	--	--	--	--	--	--	740
PCB-1254 (Aroclor 1254)	35 U	**3900**	**2300**	**3800**	**6200**	**6500**	**4300**	**5600**	--	--	--	--	740
PCB-1260 (Aroclor 1260)	35 U	**2600**	**3400**	**2700**	**5900**	**3300**	**2100**	**6800**	350 J	**3100**	290 J	690	740
gamma-Chlordane /2	3.7 U	--	--	--	--	--	--	--	--	--	--	5.7 N	6,500
alpha-Chlordane /2	0.82 J	--	--	--	--	210 N	--	--	--	--	--	--	6,500

Notes: Shaded cells represent elevated concentration compared to background; bold values represent concentration exceeding guidance value.

- a Duplicate sample
- b EPA Region 9 Preliminary Remediation Goal for industrial soil
- J Estimated value
- R Data rejected
- U Sustance was analyzed for, but not detected; value listed is the Minimun Quantitation Limit
- µg/kg Micrgrams per kilogram
- mg/kg Milligrams per kilogram
- —— Sample was not analyzed
- — No value determined

TABLE 5 (Continued)
SURFACE SOIL SAMPLE RESULTS

3

Analyte	Back-Ground	On site										Guidance
		Florida Smelting Company/Berman Brothers Scrap Yard										PRG[b]
	FB-SS-01	FB-SS-12	FB-SS-13	FB-SS-21[a]	FB-SS-14	FB-SS-15	FB-SS-16	FB-SS-17	FB-SS-18	FB-SS-19	FB-SS-20	
Metals (mg/kg)												
Silver	1.1 U	0.16 J	0.19 J	0.16 R	1.1 J	- -	- -	2.2	0.40 J	- -	- -	5,100
Arsenic	**2.1 J**	1.4 J	**2.6 J**	**2.5 J**	**22 J**	**9.8 J**	**6.3 J**	**6.7 J**	**14 J**	0.72 R	1.2 J	1.6
Barium	22	48 J	24	18 J	110	81	47	120 J	64 J	59 J	63 J	67,000
Beryllium	0.07 U	0.06 J	0.06 J	0.07 J	0.21 J	0.17 J	0.17 J	0.30 J	0.27 J	0.45 J	0.25 J	1,900
Cadmium	0.93	1.2	1.5	1.4	11	4.7	1.6	11	8.8	0.91	0.64	450
Cobalt	1.4 UJ	1.0 J	- -	- -	- -	- -	- -	3.8 J	6.2 J	1.1 J	0.51 J	1,900
Chromium	8.9	16	8.0	8.0	38	30	22	53	45	14	5.9	450
Copper	710 J	60 J	160 J	84 J	520 J	96 J	110 J	1200 J	620 J	73 J	130 J	41,000
Nickel	9.8	7.9 J	8.1	8.0	40	29	20	65 J	47 J	9.8 J	8.2 J	20,000
Lead	300	130 J	150	130	**890**	280	130	**1200 J**	570 J	160 J	280 J	800
Antimony	1.5 R	1.2 R	1.8 J	1.4 J	6.6 J	2.5 J	1.8 J	7.0 J	4.8 J	0.94 R	0.86 R	410
Selenium	3.7 U	- -	- -	- -	- -	- -	- -	- -	2.3 J	- -	- -	5,100
Thallium	2.6 U	- -	- -	- -	- -	0.93 J	- -	- -	1.5 J	- -	- -	67
Vanadium	6.9	7.3 J	7.4	7.5	22	18	12	52 J	36 J	11 J	7.5 J	1,000
Zinc	250 J	250 J	190 J	180 J	1400 J	350 J	250 J	1600 J	1200 J	190 J	190 J	100,000
Total Mercury	0.08 UJ	0.45	0.29	0.22	1.4	0.68	- -	1.5	0.92	- -	0.12	310
Aluminum	2800 J	3400 J	1800 J	1700 J	5200 J	3000 J	3100 J	9800 J	5400 J	3600 J	2300 J	100,000
Manganese	60 J	170 J	42 J	42 J	180 J	190 J	150 J	240 J	310 J	180 J	89 J	19,000
Magnesium	180 J	350 J	230 J	220 J	770 J	220 J	330 J	2200 J	860 J	1100 J	800 J	—
Iron	8100 J	5700 J	6200 J	6400 J	20000 J	27000 J	19000 J	18000 J	42000 J	5500 J	3500 J	100,000
Volatiles (µg/kg) No Analytes were Detected.												
Semi-volatiles (µg/kg)												
Acenaphthylene	290 J	--	81 J	--	270 J	370 J	490	130 J	100 J	--	--	—
Acenaphthene	350 U	--	--	--	--	--	--	--	--	--	--	29,000,000
Fluorene	350 U	--	--	--	--	--	--	--	--	--	--	26,000,000
Phenanthrene	110 J	95 J	--	--	1100 J	160 J	100 J	160 J	300 J	210 J	85 J	—
Anthracene	320 J	--	88 J	--	420 J	470	540	--	140 J	--	--	100,000,000
Fluoranthene	1100	270 J	240 J	250 J	1900	700	680	420 J	530	500	200 J	22,000,000
Pyrene	1600 J	270 J	290 J	250 J	2200	940	1200	570	730	390	220 J	29,000,000
Phenol	350 U	--	--	--	--	--	--	--	--	--	390	100,000,000
Benzyl Butyl Phthalate	350 UJ	--	--	--	--	--	--	--	--	--	--	100,000,000
bis(2-Ethylhexyl) Phthalate	350 UJ	1200 J	--	--	--	--	--	690 J	--	--	--	120,000
Benzo(a)Anthracene	780	200 J	170 J	170 J	1000 J	660	710	290 J	360 J	240 J	110 J	2,100
Chrysene	1300	300 J	190 J	200 J	1100 J	850	890	350 J	440	260 J	130 J	210,000
Di-n-Octylphthalate	350 UJ	--	--	--	--	--	--	--	--	--	--	25,000,000
Benzo(b)Fluoranthene	1500	230 J	270 J	220 J	1200	1300	1400	470 J	520 J	280 J	140 J	2,100
Benzo(k)Fluoranthene	1100	190 J	180 J	210 J	980 J	1000	960	510	530 J	260 J	140 J	21,000
Benzo-a-Pyrene	**960**	150 J	180 J	180 J	**1100 J**	**880**	**990**	**420 J**	**440 J**	**250 J**	130 J	210
Indeno (1,2,3-cd) Pyrene	930	140 J	200 J	160 J	1200	730	1200	500	370 J	180 J	90 J	2,100
Dibenzo(a,h)Anthracene	**290 J**	--	--	--	**240 J**	**240 J**	**350 J**	110 J	82 J	--	--	210
Benzo(ghi)Perylene	860	120 J	140 J	140 J	730 J	330 J	720	500	340 J	180 J	110 J	—
Dimethyl phthalate	350 U	--	--	--	--	--	--	--	--	--	--	100,000,000
Carbazole	100 J					170 J	110 J					86,000
Pesticides/PCBs (µg/kg)												
Aldrin	1.8 U	--	--	--	--	--	--	--	--	--	--	100
alpha-BHC	1.8 U	--	--	--	--	--	--	--	1.1 NJ	--	--	—

TABLE 5 (Continued)
SURFACE SOIL SAMPLE RESULTS

Analyte	Back-Ground FB-SS-01	On site: Florida Smelting Company/Berman Brothers Scrap Yard FB-SS-12	FB-SS-13	FB-SS-21[a]	FB-SS-14	FB-SS-15	FB-SS-16	FB-SS-17	FB-SS-18	FB-SS-19	FB-SS-20	Guidance PRG[b]
beta-BHC	1.8 U	--	--	--	--	--	--	--	--	--	--	—
Dieldrin	3.5 UJ	--	--	--	--	--	--	--	--	--	--	110
4,4'-DDE (p,p'-DDE)	4.3 U	--	--	--	--	--	--	31 J	27 NJ	--	8.3 NJ	7,000
4,4'-DDD (p,p'-DDD)	3.5 U	--	--	--	--	--	--	--	--	--	1.2 J	10,000
Endrin	3.7 U	--	--	--	--	--	--	--	--	--	5.6 J	180,000
Endosulfan Sulfate	5.6	--	--	--	--	--	--	--	--	--	--	—
PCB-1242 (Aroclor 1242)	35 U	--	--	--	**2800**	--	--	--	--	--	--	740
PCB-1254 (Aroclor 1254)	35 U	--	350 J	200	**2800**	**760 J**	--	--	--	--	--	740
PCB-1260 (Aroclor 1260)	35 U	610 J	260 J	160	**1300**	--	--	**3700**	**4300 J**	180 J	210 J	740
gamma-Chlordane /2	3.7 U	5.4 J	--	--	--	--	--	98	--	--	11	6,500
alpha-Chlordane /2	0.82 J	--	--	--	--	--	--	--	--	--	--	6,500

Notes: Shaded cells represent elevated concentration compared to background, and bold values represent concentration exceeding guidance value.

a Duplicate sample
b EPA Region 9 Preliminary Remediation Goal for industrial soil
J Estimated value
R Data rejected
U Sustance was analyzed for but not detected; value listed is the Minimun Quantitation Limit
µg/kg Micrgrams per kilogram
mg/kg Milligrams per kilogram
— — Sample was not analyzed
— No value determined

TABLE 6
SUBSURFACE SOIL SAMPLE RESULTS

Analyte	Back-Ground FB-SB-01	On site Florida Smelting Company Berman Brothers Scrap Yard FB-SB-02	FB-SB-03	FB-SB-04	Guidance PRG[a]
Metals (mg/kg)					
Arsenic	1.1 U	--	--	**2.3 J**	1.6
Barium	12 J	15 J	19 J	42	67,000
Beryllium	0.04 J	0.04 J	0.03 J	0.30 J	1,900
Cadmium	0.55 U	--	0.75	0.24 J	450
Cobalt	0.42 UJ	--	--	--	1,900
Chromium	3.3	3.8	3.0	6.4	450
Copper	1.9 J	0.60 J	14 J	31 J	41,000
Nickel	1.9 J	1.7 J	2.9 J	5.8	20,000
Lead	9.6	3.7	19	68	800
Antimony	6.6 UJ	--	--	1.5 R	410
Vanadium	2.8 J	4.0 J	2.6 J	6.7 J	1,000
Zinc	7.3 J	--	72 J	29 J	100,000
Total Mercury	0.04 UJ	--	--	--	310
Aluminum	3200 J	4500 J	850 J	5500 J	100,000
Manganese	19 J	4.2 J	5.1 J	16 J	19,000
Magnesium	120 J	160 J	55 J	120 J	—
Iron	2300 J	790 J	690 J	7200 J	100,000
Volatiles (µg/kg) No Analytes were Detected.					
Semi-volatiles (µg/kg)					
Fluoranthene	190 J	--	--	320 J	22,000,000
Pyrene	320 J	--	--	310 J	29,000,000
bis(2-Ethylhexyl) Phthalat	360 J	--	--	--	120,000
Benzo(a)Anthracene	110 J	--	--	150 J	2,100
Chrysene	120 J	--	--	180 J	210,000
Benzo(b)Fluoranthene	140 J	--	--	210 J	2,100
Benzo(k)Fluoranthene	140 J	--	--	170 J	21,000
Benzo-a-Pyrene	100 J	--	110 J	150 J	210
Indeno (1,2,3-cd) Pyrene	78 J	--	--	170 J	2,100
Benzo(ghi)Perylene	360 U	--	--	120 J	—
Pesticides/PCBs (µg/kg)					
Dieldrin	3.6 UJ	68 J	--	--	110
PCB-1254 (Aroclor 1254)	36 U	--	60	--	740
Endrin Aldehyde	0.79 NJ	--	--	--	—

Notes: Shaded cells represent elevated concentration compared to background; bold values represent concentration exceeding guidance value.

- a EPA Region 9 Preliminary Remediation Goal for industrial soil
- J Estimated value
- U Sustance was analyzed for, but not detected; value listed is the Minimun Quantitation Limit
- N . Tentative identification, presumptive evidence
- R Rejected data.
- µg/kg Micrgrams per kilogram
- mg/kg Milligrams per kilogram
- — — Sample was not analyzed
- — No value determined

TABLE 7
SEDIMENT SAMPLE RESULTS

Analyte	Off site				Guidance
	Florida Smelting Company Berman Brothers Scrap Yard				SSV[b]
	FB-SD-01	FB-SD-02	FB-SD-04[a]	FB-SD-03	
Metals (mg/kg)					
Silver	1.9 J	--	--	--	2
Arsenic	**8.2 J**	0.78 R	0.71 R	1.7 J	7.24
Barium	130	26 J	31	51	—
Beryllium	0.53 J	0.15 J	0.14 J	0.19 J	—
Cadmium	**11**	0.56 J	**1.1**	**1.6**	1
Chromium	**110**	11	20	33	52.3
Copper	**1200 J**	**75 J**	**160 J**	**230 J**	18.7
Nickel	**120**	7.8	**17**	**28**	15.9
Lead	**920**	**57**	**97**	**120**	30.2
Antimony	5.2 J	--	--	--	12
Vanadium	90	12	14	22	—
Zinc	**2300 J**	**130 J**	**270 J**	**400 J**	124
Total Mercury	**1.6**	--	--	**0.23**	0.13
Aluminum	15000 J	2900 J	2800 J	3500 J	—
Manganese	360 J	18 J	35 J	100 J	—
Magnesium	3300 J	240 J	330 J	2000 J	—
Iron	29000 J	5800 J	6400 J	10000 J	—
Volatiles (µg/kg)					
Acetone	140 J	--	22	23	—
Methyl Ethyl Ketone	34	--	--	--	—
1,3-Dichlorobenzene	10 J	--	--	--	—
1,4-Dichlorobenzene	18 J	--	--	--	—
1,2,4-Trichlorobenzene	14 J	--	--	--	—
Semi-volatiles (µg/kg)					
Phenanthrene	**420 J**	--	--	120 J	330
Anthracene	**400 J**	--	--	--	330
Fluoranthene	**1400 J**	160 J	170 J	**340 J**	330
Pyrene	**2100 J**	140 J	150 J	**420 J**	330
bis(2-Ethylhexyl) Phthalate	**4600 J**	--	--	**580 J**	182
Benzo(a)Anthracene	**910 J**	--	--	190 J	330
Chrysene	**1200 J**	110 J	110 J	280 J	330
Benzo(b)Fluoranthene	**1300 J**	110 J	--	280 J	655
Benzo(k)Fluoranthene	**1100 J**	120 J	100 J	230 J	655
Benzo-a-Pyrene	**1000 J**	--	--	210 J	330
Indeno (1,2,3-cd) Pyrene	**1300 J**	--	--	250 J	655
Benzo(ghi)Perylene	**1300 J**	110 J	100 J	290 J	655
Pesticides/PCBs (µg/kg)					
4,4'-DDE (p,p'-DDE)	--	--	--	2.8 J	3.3
PCB-1254 (Aroclor 1254)	**1800**	--	--	--	33
PCB-1260 (Aroclor 1260)	**2300**	**180**	**190**	**260**	33
gamma-Chlordane /2	--	**5.3**	--	**8.9 N**	1.7
alpha-Chlordane /2	--	--	--	**8.4 N**	1.7

Notes: Bold values represent concentration exceeding guidance value.

a Duplicate sample
b Region 4 Waste Management Division Sediment Screening Values.
J Estimated value
R Data rejected
U Substance was analyzed for, but not detected; value listed is the Minimum Quantitation Limit.
N Tentative identification, presumptive evidence
µg/kg Micrgrams per kilogram
mg/kg Milligrams per kilogram
— — Sample was not analyzed
— No value determined

OFFICIAL PHOTOGRAPH No. 1
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: View of background sample locations FB-01-SS and -01-SB collected north of Alternate US 1. Berman Bros can be seen on the left just beyond the bridge.

Date: June 14, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 2
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-02-SS collected west of the former furnace. Scrap metal and equipment for processing the metal was throughout the site.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 3
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-03-SS collected north of the former furnace, next to the large building on the northern border of site. The former furnace was located under the roofed structure seen in the background.

Date: June 14, 2005 **Photographer:** Jorge Snachez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 4
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-04-SS collected east of the former furnace structure seen in the background.

Date: June 14, 2005 **Photographer:** Greg Kowalski

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 5
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida		
Subject:	Location of FB-05-SS collected at the south-southwest corner of the former furnace structure.		
Date:	June 14, 2005	**Photographer:**	Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event		

OFFICIAL PHOTOGRAPH No. 6
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-06-SS collected on the northwest corner of site. The steel and pipe storage building can be seen in the background.
Date:	June 14, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 7
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-07-SS collected along the western edge of site. Scrap metal stockpiles can be seen in the background.

Date: June 13, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 8
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-08-SS collected south of the arcing railroad track going thru site. Original location was under a large scrap metal stockpile forcing the relocation of the sample.

Date: June 13, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 9
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-09-SS collected on the south side of the pipe and steel storage building.
Date:	June 14, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

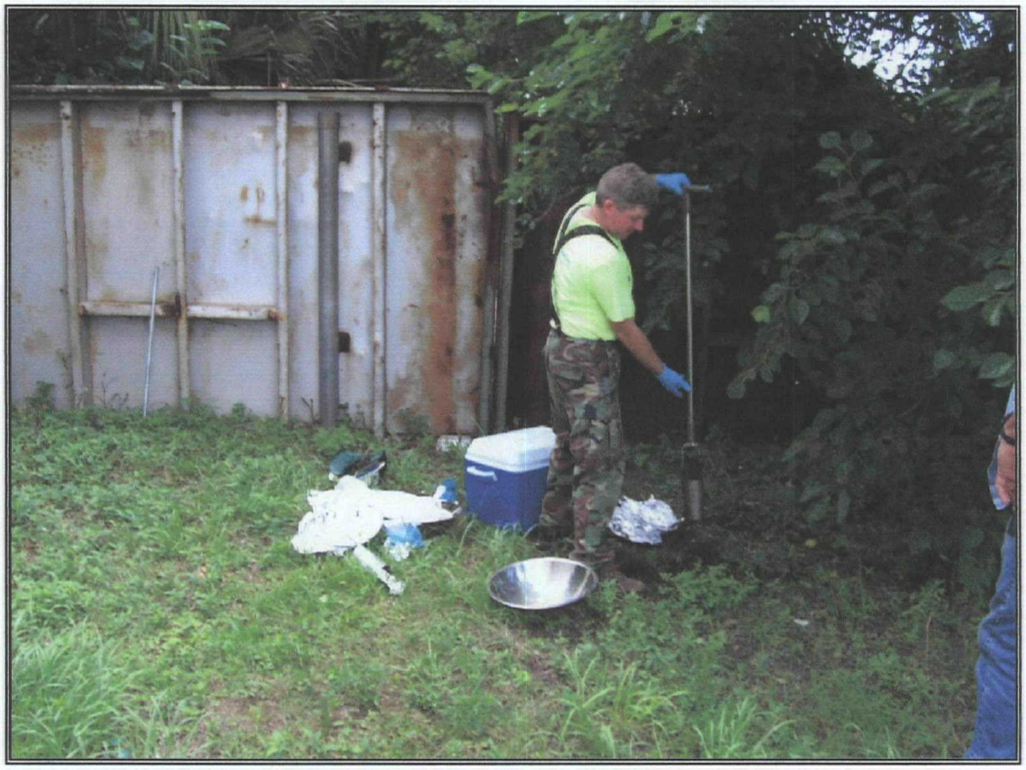
OFFICIAL PHOTOGRAPH No. 10
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-10-SS collected along the northern border of site. Alternate US 1 can be seen beyond the fence.

Date: June 14, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event



OFFICIAL PHOTOGRAPH No. 11
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-11-SS and -02-SB collected in the northeast corner of site.

Date: June 14, 2005 **Photographer:** Jorge Sanchez

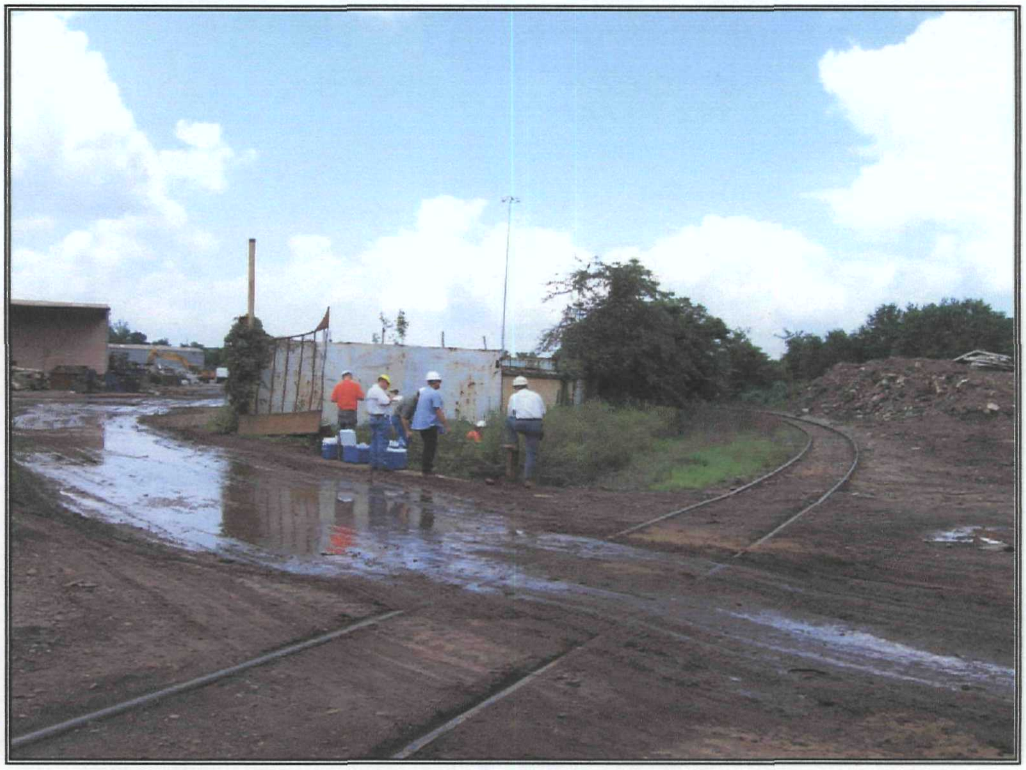
Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 12
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-12-SS collected in a grassy area south of the pipe and steel storage building.
Date:	June 14, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 13
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-13-SS and -03-SB collected south of the arcing railroad track going thru site. This drainage area continues to the east and becomes the drainage ditch.
Date:	June 13, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event



OFFICIAL PHOTOGRAPH No. 14
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-14-SS. Personnel seen throughout the photographs are representatives of Berman Bros. or Jacksonville Seaport, who accompanied the sampling teams and collected split samples from many locations.
Date:	June 13, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 15
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-15-SS collected along the railroad tracks near the point where the arcing track converges with the north-south line.

Date: June 13, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 16
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-16-SS and -04-SB collected in the southwest corner of site.

Date: June 13, 2005 **Photographer:** Jorge Sanchez

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 17
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-17-SS collected in a right of way area east of site near Evergreen Avenue.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 18
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-18-SS collected south of the arcing railroad track. The drainage route leaving site can be seen in the center and continues to the east to become the drainage ditch. The sample was collected left (south) of the drainage area.
Date:	June 13, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 19
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-19-SS collected south of the drainage ditch located just past the treeline. This area is used by Jacksonville Seaport to store railcar parts.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 20
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: Location of FB-01-SD collected in the drainage ditch leading from site. This is the first place surface water was observed in the ditch. The sample was collected upgradient of where the culvert on the left discharged into the ditch.

Date: June 14, 2005 **Photographer:** Greg Kowalski

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 21
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-02-SD collected in the drainage ditch/creek east of Phoenix Avenue, about 800 feet from site.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 22
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	Location of FB-03-SD collected in the drainage ditch/creek east of Phoenix Avenue, about 1,200 feet from site.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 23
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location: FSC Berman Site
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

Subject: View of the scrap metal processing area.

Date: June 13, 2005 **Photographer:** Greg Kowalski

Source: T N & Associates, Inc. – Superfund Technical Assessment Team
Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 24
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	View of the scrap metal processing area and the stockpiling of metal. Materials went from left to right via heavy equipment.
Date:	June 14, 2005 **Photographer:** Greg Kowalski
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

OFFICIAL PHOTOGRAPH No. 25
U.S. ENVIRONMENTAL PROTECTION AGENCY

Location:	FSC Berman Site EPA ID No. FLN000407485 Jacksonville, Duval County, Florida
Subject:	View of TN personnel heading to sample location. Debris/scrap piles were located at numerous locations across the site.
Date:	June 13, 2005 **Photographer:** Jorge Sanchez
Source:	T N & Associates, Inc. – Superfund Technical Assessment Team Site Inspection field sampling event

Appendix D

Log Notes

"Rite in the Rain"®

ALL-WEATHER WRITING PAPER

LEVEL

All-Weather Notebook

No. 311

Florida Smelting Co / Berman Bros Site
EPA ID FLN000407485
Jacksonville, Duval Co, Florida
LogBook #1

4 5/8" x 7" - 48 Numbered Pages

APRIL 11, 2003

TRAVEL TO JACKSONVILLE & PERFORM AN OFF-SITE RECONNAISSANCE OF THE FLORIDA SMELTER CO / BERMAN BROS. SITE LOCATED AT 2500 EVERGREEN AVE. THE SITE IS LOCATED IMMEDIATELY SOUTH OF US1 ALTERNATE, BETWEEN A SMALL RAIL YARD & RESIDENTIAL AREA (TO THE EAST). HOMES ARE LOCATED DIRECTLY ACROSS EVERGREEN AVE. ACCESS TO THE SITE FROM THE EAST IS RESTRICTED BY FENCING & BUILDINGS, WITH SEVERAL GATES PERMITTING ACCESS. THE SITE APPEARS TO BE COMPLETELY ACCESSIBLE FROM THE WEST, ALONG THE RR TRACKS. HEAVY EQUIPMENT CAN BE SEEN OPERATING ON SITE & ~7 CARS ARE OBSERVED IN THE OFFICE PARKING LOT. VEHICLES ARE OBSERVED ENTERING THE SITE FROM EVERGREEN AVE WITH SCRAP METAL CARGO.

Sun. June 12, 2005

With All Necessary Access Acquired
& All Consultants/Owners Notified
Of Sampling Event, TN Team Mobilizes
From Atlanta, GA To Jacksonville, FL.
Sampling Team Consists Of:
Greg Kowalski - Field Team Leader
Kelly Patton - Site H&S Officer
Allyson Warrington - Sampler/Paperwork
Jorge Sanchez - Sampler.
Using Two Vehicles, A Cargo Van

Mon June 13, 2005

Cond: Partly Sunny, Humid 80-90°

0730 Hold Safety Mtg At Hotel. Threat Is Heavy Equip./Traffic.

0750 Head To Site.

0810 Meet With Chas. Borman & Peter Kaufchinski, Discuss Planned Activities

0830 Meet With Paul Cayman (Borman Consultant).

0900 Walk Site & Set Up. With Only 1 GW Well Remaining On Site, Team Will Not Collect GW Samples. Seven Wells Previously On Site.

1000 Jason Shorsly (Jaxport Consultant) Arrives On Site.

1010 TN Collects Rinsate Blank Sample

1015 TN Collects Water Trip Blank Sample

1020 TN Collects Presv. Blank.

1025 TN Processes Soil Trip Blank

1040 TN Walks To Far/Most South Sample 16-SS. Will Collect Sub Surf. Samples 04-SB. 4 Subsurf Soil Will Be Collected From Vadose Zone In Lieu Of GW.

1050 Collect Soil 16-SS. Sub-Jaxport Splits This Sample.

1110 Collect SubSurf Soil 04-SB

June 13, 2005

1130 Collect SS-15 Split With Borman (See Logbook 2 For Sample Specs

1130 Collect SS-14, Split With Borman Borman/Jaxport Using 40ml Jars For VOA Analysis.

1210 Return To Staging Area.

1225 Secure Samples & Break For Lunch.

1320 Pick Up More Ice & Return To Site.

1325 Rick Springer On-Site To Replace Paul Layman For Borman.

1340 Head To Sample 13-SS

1345 Collect Surf Soil 13-SS / Borman Splits Also Collect Dup 21-SS At Same Loc.

1435 Collect SS-08 / Jaxport Splits. Move Location South 80' Due To Large Scrap Pile Located On Original Location.

1445 Head To SS-07 Loc After Dropping Off Samples For Processing

1500 Collect SS-07 5' North Of Light Post Split With Jaxport.

1530 Split Into 2 Teams. G. Kowalski Collects SS-02 / Splits With Jaxport.

6/13/05

Sample 02-SS Is Located 25' West Of Old Furnace. Soil Type Is A Brown Fine Sand With Small Bits Of Metallic Debris (Picked Out When Observed). Collected From 0-4" Deep. Geogr. Coords: 30° 21' 17.9" N, 81° 38' 59.7" W

1600 Collect 03-SS From 50' North Of Old Furnace 5' South Of Bldg. (See Logbk 2 For Specifics).

1620 Stop Sampling / Begin Processing Samples For Shipment.

1725 One Team Heads To UPS To Drop Samples & Return / Ship GW Sampling Equip.

1800 Drop Samples At UPS.

1815 Sample Team Heads Back To Hotel. End Of Day.

Note 1405 - Collected 03-SB, Split w/ Borman

TUES JUNE 14, 2005

CONDITIONS: CLEAR, HOT 80 - 92°, HUMID

0720 AFTER SAFETY MTG. HEAD TO PICK UP ICE & GO TO SITE.

0740 ARRIVE ON SITE & SET UP.

0840 SPLIT INTO 2 TEAMS. TEAM 1 IS K. PAYTON & JORGE SANCHEZ. THEY WILL BE SPLITTING THEIR SAMPLES WITH BARNAN (P LAYMON). TEAM 2 IS G. KOWALSKI WHO WILL BE SPLITTING SAMPLES WITH JAXSON SHEASLY FOR JAXPORT.

0900 COLLECT 18-SS / 18 TRC CONSULTANTS CHOSE NOT TO SPLIT THIS SAMPLE. COLLECTED FROM BETWEEN FENCE & DRAINAGE DITCH. AREAS TO THE WEST OF SAMPLE LOC. APPEAR TO HAVE DRAINAGE DITCH SPOILS, & THIS AREA MAY HAVE ROAD SPOILS ALSO. DENSE VEG. PRESENT. SOIL TYPE IS A BLACK TOP SOIL WITH ORGANIC MATERIAL. GPS COORDS: 30° 21' 16.3" N, 81° 38' 34.1"

0930 COLLECT 17-SS FROM R/W WEST OF E GREEN AT END OF 7TH ST. NO SPLIT SAMPLE TAKEN. SAMPLE COLLECTED 25' WEST OF E GREEN, 50' FROM RESIDENCE TO THE SOUTH. SOIL TYPE IS A BLACK TOP SOIL. GPS COORDS: 30° 21' 13.9" N, 81° 38' 36.4".

TUES. 6/14/05

1000 COLLECT 19-SS / SPLIT W/ JAXPORT. SAMPLE LOC. IS SOUTH OF SPRINGFIELD GRAIN, SOUTH OF TRACKS & DRAINAGE DITCH. AREA IS USED TO STORE RAILROAD CAR 'TRUCKS' (WHEELS). SAMPLE LOC. IS FROM UNDISTURBED AREA BEHIND TREE (NO STORAGE OF MATERIALS). SOIL TYPE IS A BLACK TOP SOIL WITH GREY SAND INTERMIXED (~20%). GPS: 30° 21' 15.9" N, 81° 38' 32.0" W

1030 COLLECT 01-SD / ~~SD~~ NO SPLIT AT THIS SAMPLE. SAMPLE COLLECTED 10' WEST OF WHERE DITCH ENTERS CULVERT TO GO UNDER PHOENIX RD. SAMPLE COLLECTED UPGRAD OF TWO DISCHARGE PIPES ENTER. SOIL TYPE IS A BLACK MUCK WITH HIGH ORGANIC MATERIAL. GPS: 30° 21' 16.9" N, 81° 38' 30.5" W

1115 MEET WITH SCOTT SCHULTZ W/ JEA. HE EXPLAINS THAT BIGELOW CREEK (DRAINAGE DITCH) ENTERS THE PLANT PROPERTY & GOES UNDERGROUND (CULVERT), BUT IS NOT TREATED BY THE PLANT (BUCKMAN TREATMENT PLANT). HE SAID THAT THE CREEK STAYS IN A CULVERT & DISCHARGES

6/14/2005

Directly Into The St. Johns River.

1200 Collect Sed Sample 03-SD/Split w/ Jaxport. Collected From North Side. Dense Vegetation In Ditch/Bigelow Crk. Soil Type Is A Black Muck With Organic Material. GPS: 30°21'16.1"N, 81°38'19.1"W.

~~1245 Collect~~ Sample Collected 50' E of Franklin St.

1245 Collect Sed Sample 02-SD/No Split. Also Collect Dupe 04-SD Here. Soil Type Is A Black Muck - Collected From North Side Of Creek. In Center Between Franklin & Phoenix Ave. No Red Flags. GPS: 30°21'16.0"N, 81°38'23.0"W.

1310 Head Back To Staging Area To Del. Samples.

1330 Break For Lunch.

1430 Return To Site. Begin Processing Samples.

1545 One Team Heads Back To Hotel. Will Upload Forms & Data; Second Team Heads To UPS To Deliver Samples.

1600 Team Delivering Samples Has A Flat Tire En Route. Change To Spare.

1630 Team Replaces Flat & Is Able To Resume Dropping Off Samples.

6/14/05

1700 Traffic & Heavy Rains Slow Trip To UPS But Samples Are Delivered For Overnight Shipment.

Shipped 2 Coolers To Liberty In Cary, NC; & 1 Cooler To Bonner In Hattiesburg, MS.

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

LEVEL

All-Weather Notebook
No. 311

Florida Smelting Company
Berman Brothers Scrap Yard
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida

4 5/8" x 7" - 48 Numbered Pages

Logbook #2

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

Name Jorge A. Sanchez
Senior Project Chemist
Address 840 Kennesaw Avenue, Suite B7
Marietta, GA. 30060
Phone 678-355-5550

Project Florida Smelting Company
Berman Brothers Scrap Yard
EPA ID No. FLN000407485
Jacksonville, Duval County, Florida.

Clear Vinyl Protective Slipcovers (Item No. 30) are available for this style of notebook. Helps protect your notebook from wear & tear. Contact your dealer or the J. L. Darling Corporation.

CONTENTS

06/12/05
14:30 - Arrived at the TN + Associates located at Kennesaw Avenue, Georgia.
- Proceeded to load vehicle with material, equipment and field Instruments.
15:15 - Left TN + Associates office via Jacksonville
08:20 - Stop for dinner Brunswick, Georgia
11:00 - Arrived at Comfort Suites Hotel Jacksonville, Florida and checked-in
Crew Consisted of the following:
Field Team Leader Greg Kowalski
Health + Safety Officer Kelly Patten
Senior Project chemist Jorge A. Sanchez
Sampling Team Member Allyson Washington

06/13/05
07:15 Conducted Site Briefing by field Team Leader Greg Kowalski.
- Conducted Safety meeting. Watch for heavy equipment traffic. Signal heavy equipment operator on your position when sampling. Watch for sharp objects, uneven grounds. Drink plenty of fluids. Level of protection Level D Hard hat, safety glasses, glove, steel toe boats

6/13/05
and orange safety vest. Weather Temperature: Todays high 89°F Partially cloudy skies. 40% chance of Scttd thunder storms. High humidity
07:30 Left hotel via site area. Stop for Ice for sample + drinking cooler.
08:15 Arrived at site area - Set-up activities.
- Briefing with company contact.
- Paul Laymon arrived at site area, he will be present for sampling event and collect samples along with TN+ Associate crew.
09:35 Set-up completed. Reconnaissance of sampling area completed. O2/LEL/PID/CO/H2S calibration in progress. Unit warm up period.

Component	Concentration	Pre Cal Reading	Post Cal reading
Isobutylene	100 ppm	201 ppm	100 ppm
CO	50 ppm	104 ppm	60 ppm
H_2S	25 ppm	39 ppm	25 ppm
LEL 50% (Methane = 2.5%)		68%	49%
O^2	20.9%	21.4	20.9%

Extra-life CO, H_2S, LEL O_2 Lot number: 50810HJ
Isobutylene TC 39M NRC 17/22 -M 1003
10:10 Filling all field Blank, rinsate + Trip blanks.

4

6/13/05

10:30 Completed all Field blanks, Trip blanks.
10:45 16 SS - ~~4SB~~ (15B) Sample Area. Soil Surface
10:50 Commence Soil Surface Soil Sample Collection for 16SS - ~~4SB~~ (15B) GPS position
N 30° 21' 24.9"
W 081° 38' 50.2" (Next To Light Tower)
VOC = 0.0 ppm
H_2O = 0.0 ppm
LEL = 0 %
O^2 = 20.9%
CO = 0 ppm
Silty Sand Soil = Description Soil
Dark Brown
Light Sand Mix
11.00 Completed sampling operations at 16SS-~~4SB~~ (15B)
Commence Auger sample collection for Soil ID # 4SB. Collect sample at 2.5 To 3 feet deep. 4SB.
- CO = 0.0 ppm - LEL = 0.0 ppm
- VOC = 0.0 ppm - O^2 = 20.9 ppm
- H_2S = 0.0 ppm
11.10 Sample ID # 4SB collected Time.
11.27 Arrived at 15 SS location. Began to start sampling event

5

* FSC: begins on picture # 11 from Digital Camera.
= Pictures from 1 To 10 belongs To another site.

6/13/05

Photo Log

Date	Photo #	Site	Description
06/13/05	1	FSC - Berman Bros	~~Soil Site area~~ Set-up area
"	2	"	South Site area
"	3	"	~~East~~ West RR Track area
"	4	"	16SS = ~~4SB~~ (15B) West position
"	5	"	16SS ~~4SB~~ (15B) West collection
"	6	"	Auger 4SB East collection
"	7	"	4SB collected
"	8	"	15 SS - west
"	9	"	15 SS - west
"	10	"	14 SS - North
"	11	"	14 SS - South/West
"	12	"	13SS/21SS ~~East~~ West
"	13	"	13SS/21SS ~~East~~ West
"	14	"	13SS/21SS South
"	15	"	03SB East
"	16	"	08SS West of Evergreen Road
"	17	"	08SS North from Residential Fence
"	18	"	07SS-East
"	19	"	07SS-West
"	20	"	04SS - South-East Furnace Bldg.
"	21	"	05SS - South ~~West~~ Furnace Bldg.
"	22	"	02SS West Furnace Bldg
"	23	"	03SS North-West Furnace Bldg

6/13/05

- Coordinates for 15SS site area

GPS Position = N 30° 21' 11.3"
W 081° 38' 41.7"

{ Silty Sand = Soil Description
{ Dirty Fine Grain Silty Sand
{ Dark Brown

CO = 0.0ppm LEL = 0.%
VOC = 0.0ppm O^2 = 20.9%
H_2S = 0.0ppm

Location: I'm between Rail Road Tracks on the V intersection heading North east from sample 16SS.

11:30 Collected Sample ID 15SS.

11:45 Arrived at sample location 14SS
Began Sampling activities

GPS Location: N 30° 21' 14.0"
W 081° 38' 39.6"

(Crossing Intersection. South from the Rail Road Tracks).

{ Fine Grain Silty Sand with Clay = Soil Description.

11:50 Sample ID. 14SS sampling time:

CO = 0.0 ppm LEL = 0.0 %
VOC = 0.0ppm O^2 = 20.9%
H_2S = 0.0ppm

6/13/05

12:00 Lunch break; gathered all materials

12:30 Left site area to have Lunch.

13:30 Returned back to site area to continue sampling.
- Rich Springer arrived to take place for Paul C.

13:45 Arrived at location to collect sample 13SS and the Associate Duplicate 21SS. Site is West of Evergreen Road on the South end of the Rail Road Track. Sample collected at this time

GPS Location N 30° 21' 15.5"
W 081° 38' 37.9"

{ Silty Sand with organics = Soil Description

CO = 0.0ppm LEL = 0.%
VOC = 0.0ppm O^2 = 20.8%
H_2S = 0.0ppm

* Location West from Evergreen Road
South from former melting building
South from V shape Railroad Track

13:00 Began Auguring Sample ID# 03SB at the same location of sample 13SS and 21SS; West from Evergreen South from Rail Road Track and North from Residencial area fence on the South end of the ditch next to the RR track.

x{ Saturated white gray sand.

6/13/05

14:05 Collected Sample ID # 03SB. Sample collected at 2.5' feet. Reached saturated white gray sand and collected sample

CO = 0.0 ppm LEL: 0.0 %
VOC = 0.0 ppm O^2 = 20.8 %
H_2S = 0.0 ppm

The sample was collected 2' North from Sample ID # 13SS and its duplicate 21SS.

14:28 Commence sampling activities for sample ID # 08SS. Locate about 60' feet west of Evergreen Road. South from a Scrap metal Stockpile and Rail Road Track and North from Residential Area chain Link fence.

14:35 Collected Sample ID # 08SS

{ Soil Description = Silty Sand Dark Brown }

GPS Location N 30° 21' 16.0"
W 081° 38' 37.0"

South from Scrap metal Stockpile + Rail Road track

CO: 0.0 ppm LEL: 0 %
VOC: 0.0 ppm O^2 = 20.9 %
H_2S = 0 ppm

14:47 Commence Sampling activities for Sample ID # 07SS

6/13/05

Sample Located between the East-West Rail Road Track and South-North Rail Road Track. Grounds are hard due to scrap metal debris. Use a heavy equipment Track-o with clippers on one end to clear one foot of debris/soil from that spot.
- Decided to move to another location to collect sample 07SS.

15:00 Collected Sample ID # 07SS East from the South-North Rail Road; North from the Electrical Light Post and West from Scrap metal Stockpile.

{ - Silty Sand, Light Brown - Soil Description No Clay. } GPS Location N 30° 21' 15.8"
W 081° 38' 41.6"

CO = 0.0 ppm LEL = 0%
VOC = 0.0 ppm O^2 = 20.8 %
H_2S = 0 ppm

15:30 Collecting Sample ID # 04SS
Located South East of Furnace former bldg. Impacted/Compacted with debris soil (Very Hard)

{ Silty Brown Sand = Soil Description -
GPS Location N 30° 21' 17.8"
W 081° 38' 38.1"

CO = 0.0 ppm H_2S = 0 ppm O^2 = 20.8 %
VOC = 0.0 ppm LEL = 0 %

6/13/05

15:45 Collecting Sample ID# 05SS
{ Silty Sand Brown: Soil Description
- Located South West corner of Former Furnace Bldg. GPS location N 30°21'17.8"
W 081°38'39.1"

CO = 0.0ppm LEL = 0%
VOC = 0.0ppm O^2 = 20.8%
H_2S = 0.0ppm

Greg Sampling:
(15:30 = Collected Sample ID# 02SS.
GPS Loc N 30°21'17.9"
W 081°38'39.7"
Silty Sandy Brown Soil
CO 0ppm LEL 0%
VOC 0ppm O^2 = 20.8%
H_2S 0ppm
Located West Former Furnace Bldg.)

16:00 Collected Sample ID# 03SS
Located North-West of Former Furnace Bldg
{ Silty Sandy Brown = Soil Description.
GPS Location N 30°21'18.6"
W 081°38'39.6"

CO: 0ppm LEL: 0%
VOC: 0ppm O^2 = 20.8%
H_2S: 0ppm

6/13, 14/05

16:30 Commence to pack coolers to be delivered to UPS overnight to reach the laboratory for Analysis.
18:00 Arrived to UPS Pritchard Avenue to deliver coolers and H_2O field Analytical equipment.
18:40 Arrived at the Comfort Suites Hotel

06/14/05

07:15 Left Comfort Suites hotel via Otrans. Conducted Tailgate safety meeting.
- watch for heavy equipment traffic
- watch for sharp objects on the grounds
- keep hydrate drink plenty of fluids
- wear sun protective lotion to prevent skin sun burns.
- watch for uneven grounds and train track rail road cars

08:00 Calibration of field Analytical Equipment

Component	Concentration	Pre Cal Reading	Post Cal Reading
Isobutylene	100ppm	100ppm	100ppm
CO	50ppm	52ppm	54ppm
H_2S	25ppm	26ppm	24ppm
LEL	50%	48%	49ppm
O^2	20.9%	20.9%	21.0%

6/14/05

Weather:
Temperature: high 92°F
Humidity = 100%
Clear skies, chance of sctd showers.

08:47 Arrived at sample location for O1SS Sample ID#. Collected Sample ID# 01-SS at this time.

Location: North from the site and property and North from US1 highway. This is the background sample. (MLK hwy).
This location a 01-SB Soil Sample will be collected.

GPS Location N 30° 21' 23.4"
W 081° 38' 42.0"

{ Silty Sandy Brown: Soil Description

CO = 0.0 ppm   LEL = 0.0%
VOC = 0.0 ppm O^2 = 20.9%
H_2S = 0.0 ppm

09:05 Very fine grain Tan clean Sand and moist. Sample depth = 3' feet. Sample ID # 01-SB. Located outside FSC Berman Bros Property & North from US-1 highway (Martin Luther king). Same location for GPS Coordinates as 01-SS.

CO = 0.0 ppm H_2S = 0.0 ppm
VOC: 0.0 ppm   LEL: 0.0% O^2 = 20.9%

6/14/05

Photo Log

Photo #	Date	Site	Description
35	6/14/05	FSC Berman Bros	01-SS/01-SB North US1
36	"	"	01-SB North US1
37	"	"	06-SS/22-SS West-South West New Steel bld.
38	"	"	09-SS North-North-West Evergreen Road.
39	"	"	09-SS " Left of New Steel Bldg
40	"	"	12-SS South: South East of New Steel Warehouse
41	"	"	02-SB South-South East of New Steel Warehouse
42	"	"	10-SS North-North-East of New Steel
43	"	"	10-SS Warehouse by Hwy
44	"	"	20-SS North-North West Murray oil cp.
45	"	"	02-SD Drainage Ditch
46	"	"	18-SS S. of Ditch
47			17-SS Right-of-way
48/49			19-SS Behind Sphildo Grain
50 51			01-SD Ditch West of Phoenix

6/14/05

6/14/05

09:25 New Steel Warehouse location for Sample ID# 06-SS and TN + Associates Duplicate 22-SS. Taken at 09:30 25 hrs.
Location: West-South-West of the New Steel Warehouse Bldg. East side of Rail Road Tracks and Steel Fence + Tabacco Packing Company.
GPS Coordinates: N 30° 21' 18.0"
W 081° 38' 41.5"
Soiltype: Silty Sandy Brown Soil.
Field Analytical: CO = 0.0ppm H_2S = 0.0ppm
VOC = 0.0ppm LEL = 0% O^2 = 20.9%

10:00 Collecting Sample ID# 09-SS
Location: North-NorthWest of Evergreen Road Left hand of New Steel Warehouse Bldg Door
GPS Coordinates: N 30° 21' 18.9"
W 081° 38' 36.2"
Soiltype Silty Sandy Brown Soil
Field Analytical: CO = 0.0ppm, H_2S = 0.0ppm, O^2 = 20.9%
VOC = 0.0ppm, LEL = 0%

10:09 - Collecting Sample ID# 12-SS.
Location South-South East from New Steel Warehouse + On grassy area right from Parking Lot. Lunch area.

6/14/05

GPS Coordinates N 30° 21' 17.7"
W 081° 38' 34.6"
Soil Type: Silty Sandy Brown Soil
Field Analytical: CO = 0.0ppm, H_2S = 0.0ppm
VOC = 0.0ppm, LEL = 0%, O^2 = 20.9%

10:37 Collecting Sample ID# 11-SS.
Location South-SouthEast Corner of New Steel Warehouse Bldg on grassy area next To the East Fence neighboring Murray Oil Corp.
GPS Coordinates: N 30° 21' 22.5"
W 081° 38' 34.0"
Soil Type: Silty Sandy Brown Soil.
Field Analytical: CO = 0.0ppm, H_2S = 0.0ppm
VOC = 0.0ppm, LEL = 0%, O^2 = 20.9%

10:53 Collecting Aquifer Sample ID 02-SB
Location: Same as 11-SS.
GPS Coordinates: Same as 11-SS.
Soil Type: Silty Sandy Brown Soil on Top 3' feet
Field Analytical: CO = 0.0ppm, H_2S = 0.0ppm
VOC = 0.0ppm, LEL = 0%, O^2 = 20.9%

- Sample Taken at 3' feet deep. To 4' deep
- Saturated at 3.5' feet. Sand Tan Light Brown. Collected Sample at almost 4' deep. Sample very moist and Light Brown Sandy

6/14/05

11:35 Collecting Sample ID# 10-SS
Location: North-North East of New Steel Warehouse. Next To Chain Link Fence. By the off ramp of Martin Luther King Blvd. Outside Concrete floor next to 2 Trees. Left from a concrete Bench Marker S-D/SW with an X on top.
GPS Coordinates N 30° 21' 21.4"
W 081° 38' 33.4"
Soil Type: Silty Sandy Brown Soil
Field Analytical: CO = 0.0ppm, H_2S = 0 ppm.
VOC = 0.0ppm, LEL: 0%, O^2: 21.1%

11:48: Collecting Sample ID# 20-SS
Location: North-North East Corner of Murray Oil Company. Inside FSC Berman Bros Fence Property and Left a West of Florida Avenue.
GPS Coordinates: N 30° 21' 29.9"
W 081° 38' 30.9"
Soil type: Silty Sand Light Brown
Field Analytical: CO: 0ppm, LEL = 0%
VOC: 0ppm, O^2 = 20.9%
H_2S = 0ppm

6/14/05

12:00 Collected Sediment samples nearby the canal located next to the Rail Road tracks.
14:00 Lunch break
14:45 Packing coolers for UPS Delivery.
15:45 Left the area via UPS.
16:00 Arrived at hotel.

6/14/05

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10762837 Site ID: FLN000040748

Site Name: Florida Smelting Company - Berman

Nature of Material:

Map: ☐ Computer Disks: ☐

Photos: ☐ CD-ROM: ☑

Blueprints: ☐ Oversized Report: ☐

Slides: ☐ Log Book: ☐

Other (describe): Analytical Data

Amount of material: ______

* Please contact the appropriate Records Center to view the material *

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10762837 Site ID: FLN000040748

Site Name: Florida Smelting Company - Berman

Nature of Material:

Map:	☒	Computer Disks:	☐
Photos:	☐	CD-ROM:	☐
Blueprints:	☐	Oversized Report:	☐
Slides:	☐	Log Book:	☐

Other (describe): Wadiius Map (Ref. 1)

Amount of material:

* Please contact the appropriate Records Center to view the material *

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

July 15, 2002

Ms. Barbara Dick
U.S. Environmental Protection Agency
Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Re: Preliminary Assessment Report / PA Scoresheets
Florida Smelting Company aka. Berman Brothers Scrap Yard
Jacksonville, Duval County, Florida

Dear Barbara:

Please find enclosed a copy of the Preliminary Assessment(PA) Report, and PA Scoresheets for the Florida Smelting Company site. In an effort to expedite this report, the reference package will be sent to you separately. This site is a FY2002 Preliminary Assessment commitment. Based on the site file information, the site is recommended for further CERCLA action. If you have any questions please call me at (850) 488-3935. Thank you.

Sincerely,

Teresa Kinner
Environmental Specialist II
Site Screening Superfund Subsection
Bureau of Waste Cleanup

Enclosure

cc: Reading File
Jim McCarthy

PRELIMINARY ASSESSMENT
FLORIDA SMELTING COMPANY
AKA: BERMAN BROTHERS SCRAP YARD
DUVAL COUNTY, FLORIDA

EPA ID No: ____________

FLORIDA

Prepared By:

Florida Department of Environmental Protection
Division of Waste Management
Bureau of Waste Clean-up
Technical Review Section
Site Screening Superfund Subsection

A. James McCarthy Jr., P.G
Professional Geologist I
July 10, 2002

Date: 07/10/02

Prepared by:

A. James McCarthy Jr., P.G.
FDEP

Site:

Florida Smelting Co.
Aka: Berman Brothers Scrap Yard
2726 Evergreen Avenue
Jacksonville, Duval County, Florida

EPA ID No: ________________

1.0 Introduction

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Re-authorization Act of 1986 (SARA), the Florida Department of Environmental Protection (FDEP), Division of Waste Management, Site Screening Superfund Subsection conducted a Preliminary Assessment (PA) for the Florida Smelting Co. aka: Berman Brothers Scrap Yard site in Jacksonville, Duval County, Florida. The purpose of this investigation was to assess the threat posed to human health and the environment, and to determine the need for additional investigation under CERCLA/SARA or other action. The scope of the investigation included review of available file information and a comprehensive target survey.

2.0 Site Background

2.1 Location

The Florida Smelting Co. aka Berman Brothers Scrap Yard site is located at 2726 Evergreen Avenue, Jacksonville, Duval County, Florida. The approximate latitudinal and longitudinal coordinates of the site are 30° 21'16" N and 81° 38' 39" W, respectively. The site is also defined as being located in Section 6, Township 2 South, Range 27 East. From. Interstate 95 (I-95) take the 20th Street Expressway (aka; US1A) east. Go past Main Street intersection to the Evergreen Avenue intersection. Take a right (head south) onto Evergreen Avenue. The site is located one block south of the intersection on the right hand (west side) side of the road [60,68] (Figures 1,2).

2.2 Site Description

The Florida Smelting Co (FSC) began operating in 1940 and since the beginning of its operations has been known to have another address of 18th Street and Evergreen. FSC

operated at the 2726 Evergreen Avenue location until at least 1946, when the site became Albright and Company, Junk. In 1950, it appears that FSC began operations at another facility at 5800 Buffalo Avenue. Berman Brothers Incorporated, a scrap metal processor, currently occupies the site and has owned the property since 1965. Over the years, the site expanded east and south and presently encompasses an area of about 18 acres. The former FSC property is contiguous with their facility at 2500 Evergreen Avenue. The Berman Brothers property consists of a warehouse (structural steel and pipe storage), the Crane Building and a furnace. Scrap metal processing and materials storage is conducted in the northern part of the property. Ferrous metal recovery and processing is conducted in the southwest portion of the property at the Motor Assembly (Shear House) area and metal shredder. The site is bounded to the north by the 20th Street Expressway and to the east by Preston Street and Florida Avenue. CSX railroad borders the site on the west while 16th and 17th street are located to the south. The site area is a mixture of industrial/commercial businesses and residential housing. A low-income single family residential housing complex is located near the site [56,60,68] (Figures 1,2,3,5).

2.3 Local Climate

Duval County has a humid, subtropical climate. The mean annual temperature in Jacksonville is approximately 69° F. The mean monthly temperatures for the warmest month (July) and coldest month (January) are approximately 82.6° F and 55.9° F, respectively. The annual rainfall in the Jacksonville averages about 54 inches. However, as a result of local thunderstorms, rainfall amounts vary from place to place within the county. Over a 30-year period (1938-68), the annual rainfall ranged from 36.83 to 77.37 inches. The majority of rainfall (60-70%) occurs between June and October during the area's wet season. The Net Precipitation and 2-year, 24 hour rainfall values for the Jacksonville area are approximately 8 and 5 inches, respectively. The FSC site is located outside the 500-year floodplain [6,7,8,9,24,35].

3.0 Site History

3.1 Operational History and Waste Characteristics-General Process

The typical secondary smelting process involved lead scrap and lead components from used car batteries. The lead posts and grids were recovered from the batteries for smelting. The smelter operation typically consisted of reverberatory or blast furnaces, which were used to produce soft pure lead or specialty alloys. As part of the refining process, some smelting operations introduced antimony, arsenic and cadmium for the desired product. The furnaces were periodically opened to remove slag (60-70% lead) and a soft pure lead product [44,46,47,49,50].

Several public health organizations and EPA have identified a number of companies that conducted secondary lead smelting in the United States. This smelting process utilized the recovery of lead metal and alloys from various forms of scarp including lead acid batteries. The FSC site was one of those companies identified in the studies.

It has been determined that lead concentrations in surface soils at smelter sites may exceed 1% near the smelters or furnaces. A study of soils at eight former secondary smelting facilities in Baltimore and Philadelphia indicated lead concentrations ranging from 306 milligrams per kilogram [mg/kg] to 2,550 mg/kg. EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) have identified lead as the leading priority contaminant at Superfund sites. Both EPA and ATSDR consider lead a serious public health problem, particularly in children [44,46,47,49,50].

3.2 Operational History and Waste Characteristics-Specific Site Process

FSC reportedly performed lead smelting. Site file information indicates that FSC used batteries as a primary feedstock for lead. The site file also indicates that a scrap yard existed at this site since the 1930's [60,68]. It is reported that ferrous and non-ferrous processing operations have been conducted in the northern portion of the site throughout its history. A metal compacting machine, which was hydraulically powered, was formerly located at the site. As a result, other sources of scrap lead were likely used at the site. The operations at Berman Brothers, Inc. consists of non-ferrous scrap processing of copper, brass, aluminum, lead, stainless steel and ferrous scrap processing and storage of new structural steel and piping supplies. Approximately 60% of the scrap operation involve new steel. However, a smelting furnace is used for aluminum and zinc extraction. The dross is reportedly stockpiled adjacent to the building. It is currently unclear whether this furnace is the same as the one used by FSC. Hundreds of transformers from the Jacksonville Electric Authority (JEA) were stored on site. This portion of the site was reportedly leased from the Jacksonville Port Authority (JPA). The oils in the transformers, which contained Polychlorinated Biphenyls (PCBs), were removed and placed into two on-site tanks (10,000 gallon and 6,000 gallon capacity). Numerous spills were reported to have occurred as a result of these activities. The owner reported that most of the oil was sold [47,55,56,60,68,110] (Figure 3).

3.3 Site Ownership

Charles Berman of Berman Brothers, Inc. 2500 Evergreen Avenue Jacksonville, Florida 32206, has been identified as a potential responsible party [PRP]. The telephone number for Berman Brothers is (904) 353-3694. The site was reportedly owned by the Wolfson family prior to World War II [63]. Very little information regarding the Florida Smelting Co. ownership is currently available.

3.4 Regulatory/Permitting History

On March 25, 1985, the Florida Department of Environmental Regulation (FDER) conducted a field inspection of the Berman Brothers property located at 2500 Evergreen Avenue. Based on the investigation, it was determined that a 275 foot x 150 foot area was impacted by spilled transformer oil. The oil was later determined to contain PCBs. The oil was stored in JEA transformers located on the property [51,52] (Figure 3). A Warning Notice Letter (NE-W-16-2348) was forwarded to Charles Berman on April 12, 1985. The

letter cited improper PCB disposal and required contaminated soil and free product removal. A groundwater contamination assessment was also requested [51,53]. Berman Brothers subsequently notified FDER that it would cooperate with the cleanup and assessment of the site [51].

On December 8, 1987, FDER notified Berman Brothers that a final report regarding cleanup and assessment of the site had not been forwarded to the Department [54]. A follow-up letter was sent by FDER to Berman Brothers on March 30, 1988 [51].

On May 26, 1988, FDER and Berman Brothers met to discuss the site. Berman Brothers stated that the transformers were acquired from JEA and that the oil had been transferred to two tanks. During the activities, oil was spilled onto the ground. FDER informed Berman Brothers that a Consent Order requiring a Preliminary Contamination Assessment Plan was needed [51,55].

On April 29, 1991, as part of the Consent Order negotiations, the Berman Brothers attorney requested that the Consent Order be limited to only the area where the transformers were received and dismantled and not the entire scarp yard site [56]. On July 25, 1991, FDER and Berman Brother entered into a Consent Order (OGC File No. 91-0681). The Consent Order pertained only to the portion of the site where transformers were received and dismantled. The Consent Order required a Preliminary Contamination Assessment be conducted under the requirements of the Department's Corrective Actions for Groundwater Contamination Cases document [57].

In August 1991, a Preliminary Contamination Assessment Plan (PCAP) was submitted to FDER by the Berman Brothers consultant, Pitman Hartenstein & Ashe, Inc (PH&A) [58]. The plan called for groundwater and soil assessment in the area of former transformer activities. FDER approved the plan on October 18, 1991 provided the consultant provide FDER with the parameter sampling protocol [59].

In February 1992, PH&A and Intergrated Environmental Solutions Inc (IES). submitted the Preliminary Contamination Assessment Report (PCAR) to FDER for the Berman Brothers Inc. site. Detectable levels of PCBs and lead were found in the site soils and groundwater. Free phase hydraulic oil was also detected in groundwater. Please refer to Section 3.5.1 for a detailed discussion of the PCAR results [60]. On February 25, 1992, FDER completed its review of the PCAR and notified Berman Brothers that further contamination assessment and remediation was required [61].

On June 9, 1992, PH&A submitted an Initial Remedial Action Plan (IRAP) for the site. This plan was prepared by D.L. Smith and Associates (DLS) and addressed further soil assessment, soil excavation and free product recovery of oil from impacted groundwater [62].

A Contamination Assessment Plan (CAP) was submitted to FDER by PH&A and DLS on September 8, 1992. The CAP included additional monitor well installation, soil sampling,

groundwater sampling of the existing and newly installed wells and laboratory testing of the samples. This plan addressed only the area of transformer storage and oil draining operations [63]. FDER completed its initial review of the CAP on January 4, 1993 and forwarded comments to DLS [64]. DLS responded to the comments on March 23, 1993 [66]. FDER ultimately approved the CAP, with revisions, on June 22, 1993 [67].

On March 23, 1993, PH&A provided FDER with a summary of the Initial Remedial Action (IRA) conducted at the Berman Brothers site. This IRA included the removal of approximately 3,000 gallons of contaminated groundwater and 150 gallons of free product (hydraulic fluid/lubricating oil). The product recovery system utilized an open excavation for the recovery of free product. Both the free product and contaminated groundwater were stored in separate tanks at the site. Approximately 450 tons of contaminated soil was reportedly excavated and sent to Recycling Alternatives, Inc in Adel, Georgia for incineration [65,93].

A Contamination Assessment Report (CAR) was completed by DLS and submitted to the Florida Department of Environmental Protection (FDEP) on February 23, 1994. The report indicated that the IRA resulted in 595.4 tons of contaminated soil being removed and shipped to Roswell Asphalt Co in Kingsland Georgia for use in the asphalt manufacturing process. In addition, approximately 400 gallons of hydraulic fluid/lubricating oil product was recovered from a shallow pond constructed in the area containing free oil product [68,93] (Figure 5).

The contamination assessment included the installation of additional monitor wells, soil sampling, groundwater sampling of the existing and newly installed wells and laboratory testing of the samples. This assessment addressed only the area of transformer storage and oil draining operations. PCBs were detected in a groundwater sample. Soil samples collected at the site contained barium and PCBs. DLS concluded that the phase separated hydraulic fluid/lubrication oil was confined to a small area of the site [68] (Figure 5). Please refer to Section 3.5.2 for a detailed discussion of the CAR results.

FDEP completed its review of the CAR on May 2, 1994. FDEP requested additional information regarding the fate of the free product recovery excavation, the extent of free product contamination and the soil assessment plan [69]. Earth Systems, formerly DLS, responded to the FDEP comments on May 17, 1994. Earth Systems indicated that the on-site excavation was temporary and would be filled in when the free product recovery operation was complete. The results of a recent qualitative soil survey were presented in the reply. Additional soil assessment plans were also indicated. Please refer to Section 3.5.3 for a detailed discussion of the qualitative soil survey results [70].

FDEP reviewed the soil survey results on July 14, 1994 and requested that the area of soil assessment be expanded to the south and west of the original free phase plume area. FDEP also requested that the proposed soil sampling grid system for PCB delineation be expanded to include the MW-4 area. FDEP also indicated that additional recovery wells could be necessary [71]. Earth Systems responded to the FDEP letter on September 12,

1994. Earth Systems indicated that an additional qualitative soil survey would be conducted and proposed expanding the soil-sampling grid for PCB contamination delineation [72]. On September 22, 1994, FDEP agreed with the changes in scope and advised Earth Systems to proceed with additional contamination assessment of the site [73].

On October 4, 1995, FDEP sent a Warning Letter (WL95-0082 CU16-NED) to Berman Brothers for failure to copy with the terms of the Consent Order. On February 9, 1996, Berman Brother informed FDEP that additional assessment activities had been conducted at the site. FDEP indicated that unless a CAR Addendum was submitted, the Department would pursue legal action [74]. Earth Systems faxed the recent soil sample results to FDEP on February 9, 1996 [75]. On February 13, 1996, based on a review of the faxed information, FDEP issued a Non-Compliance Letter (NCL96-0001-NED) to Berman Brothers Inc. FDEP based the letter on the limited scope of assessment conducted at the site since the execution of the Consent Order [76].

On April 1, 1996, Earth Systems Group Inc. responded to the Department's Non-Compliance letter. The letter included the results of recent contamination assessment addendum activities undertaken at the Berman Brothers site. Additional PCB soil contamination was noted. Since no additional free phase product was detected in the temporary well points, Earth Systems indicated that no additional recovery wells were necessary. The letter report also outlined additional soil boring assessment plans for the site [77]. Please refer to Section 3.5.3 for a detailed discussion of the additional assessment results. FDER completed its review of the CAR addendum on April 4, 1996. FDEP requested additional assessment of PCBs in the SB-2 and MW-4 areas. FDEP also forwarded questions regarding the character of the free phase product [78] (Figure 6).

On June 4, 1996, Berman Brother Inc. notified FDEP that the product recovery excavation had been closed out with clean fill. In an effort to return the area for scrap yard operations, Berman Brothers offered to conduct long term groundwater monitoring and perform addition assessment of the SB-2 and SB-4 areas [79] (Figure 6). The same day, Earth Systems responded to the FDEP CAR Addendum comments. Additional groundwater and soil assessment results were included in the response [80]. Please refer to Section 3.5.3 for a detailed discussion of the post CAR addendum assessment results.

On August 7, 1996, representatives from FDEP and Berman Brothers met to discuss the site progress. A summary of the meeting was presented in a September 17, 1996 letter sent to Berman Brothers. Soil cleanup goals and soil excavation requirements were discussed. Additional soil sampling was required in the SB-1 area to determine the extent of PCB contamination. The extent of Total Petroleum Hydrocarbon contamination in the SB-17, PB-1 and PB-2 areas also needed to be determined. Post IRA groundwater-monitoring requirements were also discussed [82] (Figure 7)

On September 2, 1996, Berman Brothers notified FDEP that it would excavate and dispose of oil stained soil. Berman Brothers indicated that the excavated soil would be

properly disposed and the area would be covered with clean back fill. Berman Brothers also indicated that additional groundwater and soil assessment would be conducted to delineate the extent of the free product plume and PCBs, respectively [81]. Berman Brother notified FDEP on November 22, 1996 that an additional 27,980 pounds of oil stained soil had been removed from the site and disposed. A follow-up letter from FDEP on January 7, 1997 notified Berman Brothers of the documentation requirements [83].

On December 12, 1997, FDEP notified Berman Brothers that additional soil assessment was necessary. FDEP also expressed concerns regarding the length of time that had transpired to complete the assessment and remediation requirements of the 1991 Consent Order [87].

On July 8, 1998, an attorney for Berman Brothers Inc. informed FDEP that PCB contaminated soil had been excavated from the site and disposed at the Kedesh, Inc. Soil Recycling facility in Screven, Georgia. FDEP subsequently received invoices from the facility documenting the receipt of 908.09 tons of non-hazardous petroleum contaminated soils [88,89]. The area of soil excavation was estimated to be 80 feet by 40 feet and 4 feet deep. However, the attorney informed FDEP that the fill material placed in the excavation had shown to be contaminated by PCBs. This material was purchased from a north side Jacksonville location. The attorney indicated that the fill sample analytical results would be forwarded to FDEP [88]. The analyses subsequently forwarded to FDEP indicated the presence of PCBs in the fill material [91]. Please refer to Section 3.5.3 for a detailed discussion of the fill material PCB results.

On July 24, 1998, FGS-Jacksonville, Inc. reported the results of PCB soil testing at the off-site source pit for the fill. No PCBs were detected in the soil samples collected from the loading area adjacent to the excavation. As such, FGS determined that the contaminated fill placed at the Berman Brothers site did not originate from this area [90].

A meeting was held between FDEP and Berman Brothers representatives on July 29, 1998. It was determined that no evidence of PCB contamination from the fill source site existed. Berman Brothers representatives indicated that a Supplemental Contamination Assessment Plan would be delivered to FDEP in August 1998 [92]. A Supplemental Contamination Assessment Plan (SCAP) was submitted to FDEP on October 1, 1998. The plan called for additional soil assessment of PCBs near the SB-2 boring location. FDEP deemed that the SCAP was acceptable provided the plan include additional analyses in the area between SB-4 and SB-13 [93] (Figure 7).

On September 27, 1999, Dominion completed a Supplemental Contamination Assessment Report (SCAR) for the Berman Brothers Site. The report was received by FDEP on October 20, 1999. PCBs were detected in soil samples in excess of the State industrial cleanup criteria for PCBs. Please refer to Section 3.5.3 for a detailed discussion of the soil assessment results. Dominion recommended a number of remedial options including soil excavation and disposal or disposal in combination with institutional controls such as asphalt or concrete paving [94]. FDEP notified Dominion on October 21, 1999 that the

SCAR and previous assessment reports adequately defined the extent of PCB contamination and that an Interim Remedial Action Plan (IRAP) needed to be submitted. FDEP also stated that the IRAP needed a proposal for post excavation confirmatory soil sampling, groundwater quality assessment and plans for institutional controls [95].

Dominion submitted an IRAP to FDEP on December 1, 1999. To further delineate the extent of PCB soil contamination, additional soil sampling was proposed. Following the delineation, the IRAP called for excavation and transportation of PCB contaminated soils to a soil treatment facility. Confirmatory soil sampling would then be performed. The State residential PCB SCTL of 0.9 mg/kg was established as the soil cleanup goal. Additional monitor wells would be installed to supplement the existing wells in order to assess groundwater quality [96]. FDEP subsequently reviewed and approved the IRAP on December 2, 1999 [97].

On February 18, 2000, Dominion notified FDEP that the additional soil assessment had been completed and the excavation portion of the IRAP was about to commence [98]. On July 21, 2000, since an Interim Remedial Action report had not be received, FDEP sent a letter to Berman Brothers Inc. informing them that they had 15 days to report the progress of the project [99].

On January 5, 2001, Dominion forwarded a letter to FDEP with an IRAP update of the Berman Brothers site. Dominion attributed the Interim Remedial Action delays to equipment and weather problems. The letter indicated that the removal and disposal phase had been completed. Groundwater and confirmatory soil samples were reportedly collected on November 27, 2000. No PCBs were detected in the groundwater samples. However, several of the soil sample locations (C-2, C-3, C-4 and C-8) had PCB levels in excess of the State residential SCTL. Berman Brothers agreed to additional soil sampling in those areas [100].

On June 18, 2001, Dominion completed an Interim Remedial Actions report for the Berman Brothers site. The report was subsequently forwarded to FDEP on June 19, 2001. The report summarized the assessment and remedial actions taken at the site. These actions included additional soil assessment activities, excavation and removal of 435 tons of PCB contaminated soil and confirmatory soil and groundwater testing. Based on the test results, Dominion recommended that No Further Action be taken at the site [101]. Please refer to Section 3.5.3 for a detailed discussion of the Interim Remedial Action report results.

FDEP forwarded a letter to Berman Brothers on July 17, 2001 with its comments regarding the Interim Remedial Action report. A number of deficiencies were noted. These included improper confirmation sampling techniques, inadequate backfill testing and disposal manifest deficiencies [102].

On December 10, 2001, Dominion responded to the Department's comments on the Interim Remedial Action report. The response letter included revised laboratory reports

and stated that the confirmatory sampling techniques had been previously approved by FDEP. Dominion stated that the source of the backfill was four lakes from an unused, undeveloped subdivision and it was unlikely that PCBs originated from this area. Dominion attributed the PCB detections in the fill to absorption and/or laboratory errors. Dominion also indicated that since the PCB levels were not elevated enough to be considered hazardous waste, the Kedesh soil treatment facility was an appropriate location for disposal [103].

On December 13, 2001, FDEP contacted the Georgia Department of Environmental Protection (GDEP) regarding the fate of the contaminated soil from Berman Brothers. GDEP indicated that Kedesh was not a permitted PCB disposal facility and that Toxicity Characteristic Leaching Procedure (TCLP) testing was not performed as required. Kedesh also indicated that it had no record of soil received from Berman Brothers for the October-November 2000 time frame [104].

FDEP sent a letter to Berman Brothers on December 18, 2001 regarding the Interim Remedial Action deficiencies. FDEP indicated that the revised laboratory report and confirmation soil sampling responses were acceptable. However, FDEP requested a Disposal Manifest or a Certificate of Treatment for the PCB contaminated soils. In addition, FDEP notified Berman Brothers that a disposal facility must be certified to accept PCB wastes. Documentation for the waste processing/disposal facility was requested [105].

On January 17, 2002, FDEP's Office of General Counsel (OGC) sent a letter to Berman Brothers requesting a Disposal Manifest or Certificate of Treatment for the 435 tons of PCB contaminated soil that reportedly took place in October 2000. FDEP informed Berman Brothers that they had 14 days to provide the documentation or FDEP would consider filing a Petition to Enforce the Consent Order [106]. To date, no documentation regarding the proper disposal of the PCB contaminated soil has been received by FDEP [108].

On February 28, 2002, GATX Railroad delivered a tanker car to Berman Brothers from Georgia for scrap. The tanker car was manifested as clean. However, some residues still remained. A worker at the scrap yard started to cut up the old tank car for scrap metal. However, a black liquid started to leak onto the ground. About 400 gallons of what was later identified as "black liquor" spilled from the tanker onto the ground. A contractor hired by Berman Brothers Inc subsequently cleaned up the spill. The cleaning contractor, Environmental Recovery, now Mirand Environmental, notified FDEP of the spill on March 6, 2002 of the cleanup [107].

In late 2001, EPA referred five secondary lead smelting sites, including the FSC site, to the FDEP for prescreening. FDEP completed a Pre-CERCLIS Screening Assessment Checklist/Decision report on April 25, 2002. The report identified the site location, described potential lead problems possibly associated with the site and identified

potential receptors. Based on the findings of the report, the site was recommended for entry onto CERCLIS [43,45,48].

In April 2002, FDEP completed a Windshield Survey of the FSC site. The survey pinpointed the site location and noted that the site was active and occupied by a scrap metal company. Large piles of scarp metal, including old tanks, were visible. The site was partially fenced. However, site access was not restricted [109].

3.5 Sampling and Analysis

Based on a review of the site file, it appears that the sampling activities were limited to the area where transformer operations took place.

3.5.1 Preliminary Contamination Assessment Results

A PCAR was submitted to FDER in February 1992. The fieldwork for the preliminary contamination assessment was conducted between August 1991 and January 1992. The assessment included a groundwater flow evaluation, monitor well installation and groundwater/soil sampling analysis [58,60].

Three piezometers were installed to determine groundwater flow across the site. The water table elevations measured in August 1991 indicated a south-southwest groundwater flow direction. [58,60] (Figure 3). However, water table elevations measured in January 1992, using both the piezometers and monitoring wells, indicated a groundwater flow direction to the north and north-northwest [58,60] (Figure 3).

Three monitor wells (MW-2, MW-3 & MW-4) were installed in the area of the transformer storage and drainage activities. The wells were constructed of 2-inch diameter, Schedule 40 PVC. Monitor well MW-1 was installed to the north, adjacent to the Crane building, for background purposes. The wells were installed to a depth of 12 feet below land surface (bls). This included ten feet of slotted (0.01 inch) PVC screen. Groundwater (two rounds) and soil samples were collected and analyzed for PCBs and total metals (eight RCRA metals) [60,68] (Figure 4).

Soil samples were collected in early December 1991. A composite soil sample was collected at each monitor well location. The sampling interval included from land surface to the water table interface. Barium (1.08 milligrams per kilogram [mg/kg] to 5.14 mg/kg) was detected in all four soil samples. PCBs were detected in the soil samples collected from MW-2 (5 mg/kg) and MW-4 (3 mg/kg). Chromium (1.16 mg/kg) was detected in the soil sample from MW-3. Lead was detected in the soil samples from MW-2 (7.6 mg/kg), MW-3 (40.8 mg/kg) and MW-4 (2.9 mg/kg). It should be noted that the highest level of lead was detected from the soil sample collected nearest the furnace [60] (Figure 4).

The initial round of groundwater sampling was conducted on December 3, 1991. Oil free product, greater than two feet in thickness, was observed in monitor well MW-2. Barium (0.096 milligrams per liter [mg/l] to 0.446 mg/l) was detected in all four wells. PCBs were detected in monitor well MW-2 (5 micrograms per liter [ug/l]) and MW-4 (10 ug/l). Lead was detected in monitor wells MW-1 (0.483 mg/l), MW-2 (0.065 mg/l), MW-3 (0.525 mg/l) and MW-4 (0.44 mg/l). Again, the highest levels of lead were detected in the sample (MW-3) located closest to the furnace. The lead levels were in excess of the existing primary drinking water standard (PDWS) of 0.05 mg/l. The PCB concentrations were in excess of the State Groundwater Guidance Concentration of 0.5 ug/l. A second round of sampling was conducted between January 9 and January 27, 1992. Only the wells that had previously shown PCB and lead contamination were sampled and analyzed. No PCBs or lead were detected above the detection limit. The consultant attributed the initial lead and PCB detections to soil disturbance during well installation and turbidity problems [60] (Figure 4, Tables 1-3).

On June 12, 1992, a soil sample (SS-1) was collected near monitor well MW-2 for polynuclear aromatic hydrocarbons [PAHs] (EPA Method 8310) and PCB (EPA Method 8080) analysis. The sample was collected using a hand auger just above the water table interface. A number of PAH and PCB compounds were detected. The PAH contaminants included benzo [a] anthracene (88 micrograms per kilogram [ug/kg]), benzo [k] fluoranthene (31 ug/kg), dibenzo [a,h] anthracene [51 ug/kg], fluorene (13 ug/kg), phenanthrene (84 ug/kg), 1-methylnaphthalene (34 ug/kg) and 2-methylnaphthalene (42 ug/kg). Arochlor 1248, (8 mg/kg), a PCB compound, was also detected [68] (Figure 4).

3.5.2 Contamination Assessment Results

On February 25, 1994, DLS (aka: Earth Systems) completed a CAR for the Berman Brothers site. As detailed earlier, the contamination assessment included the installation of additional monitor wells, soil sampling, and groundwater sampling of the existing and newly installed wells and laboratory testing of the samples. This assessment addressed only the area of transformer storage and oil draining operations. The fieldwork for the contamination assessment was conducted between September 1993 and February 1994 [68].

Field screening was conducted during the installation of the new monitor wells. Soil samples were collected from land surface to 3 feet bls. The selected samples were subsequently screened using an Organic Vapor Analyzer (OVA) equipped with a Flame Ionization detector (FID). A soil sample collected from 3 feet bls from monitor well MW-7 had a total vapor reading of 15 parts per million [PPM]. Low levels of vapors were also detected in the MW-8D 1-foot (2 PPM) and 3 foot (4 PPM) samples. None of the other soil samples collected from the well borings exhibited any detectable vapor readings [68] (Figure 5).

On September 14, 1993, during the installation of the new monitor wells, soil samples were collected from MW-6 and MW-8D for laboratory analysis. The samples were

composited from land surface to the water table interface (approximately 3 feet bls). The samples were analyzed for RCRA metals, PCBs and PAHs. Low levels of barium (3 & 4 mg/kg) and chromium (3 & 3 mg/kg) were detected in the two samples. Arochlor 1254 (54 ug/kg) and Arochlor 1248 (54 ug/kg) were detected in the soil samples from MW-6 and MW-8D, respectively. No PAH compounds were detected above the minimum detection limits [68] (Figure 5, Table 2).

Four monitor wells (MW-5, MW-6, MW-7 & MW-8D) were installed on September 14, 1993 to delineate the area of contamination. The wells were constructed of 2-inch diameter, Schedule 40 PVC. Monitor wells MW-5, MW-6 and MW-7 were installed to a depth of 17 feet bls with 15 feet of slotted (0.01 inch) screen. Monitor well MW-8D was installed to a depth of 35 feet with 5 feet of slotted screen [68] (Figure 5).

Groundwater samples were collected on November 2, 1993 and February 4, 1994. Both the existing and newly installed wells were sampled during the November 1993 sampling event for PCBs (EPA Method 608) and PAHs (EPA Method 610/8100). No metals analysis was conducted. Monitor well MW-2 was not sampled due to the presence of free product. Arochlor 1242 (250 ug/l) and arochlor 1260 (11 ug/l), PCB compounds, were detected in monitor well MW-4. No other PCBs or PAHs were detected in the groundwater samples. Monitor well MW-4 was resampled on February 4, 1994. Both filtered (dissolved metals) and unfiltered (total metals) samples were collected for PCB analysis. The aliquot for PCB dissolved metals analysis was poured directly from the bailer through a 45-micron filter. Arochlor 1242 (200 ug/l) and arochlor 1260 (8.2 ug/l) were detected in the unfiltered (total metals) sample. No PCBs were detected, above the minimum detection limit, in the filtered (dissolved metals) sample. DLS attributed the PCBs detected in the unfiltered sample to suspended sediments in the water column [68] (Figure 5, Table 3).

Water table elevations were measured in the monitor wells on three separate occasions (11/2/93, 1/7/94 & 1/31/94). Groundwater flow across the area of investigation was generally to the northwest and north-northwest. However, groundwater was determined to flow east-northeast and northeast during high water table conditions [68].

3.5.3 Post Contamination Assessment Report Results

A qualitative soil survey was conducted by Earth Systems in May 1994. Nineteen soil borings (S1 to S19) were conducted to further delineate (visually and olfactory) the extent of free product at the site. Stockpiled scrap metal and soil, located south and west of the area, were removed to conduct the survey. Additional areas of free product and oil odors were identified at the Berman Brothers site between the railroad spur and the recovery system excavation [70] (Figure 5).

On October 27, 1995, five soil borings were installed at the Berman Brothers Inc. site. Five additional borings and three temporary well points (TWP-1, TWP-2 & TWP-3) were installed on February 21, 1996. However, soon after installation, one of the well

points (TWP-3) was destroyed by on-site activities. Soil samples were collected from the ten soil borings (S1 to S10) for PCB analyses [77]. The well points were installed to identify free phase hydrocarbons southwest of the pond. The two remaining wells (TWP-1 & TWP-2) were equipped with an oil interface meter for the detection of free product. No hydrocarbon odors, staining or free product were noted in the two remaining well points. No groundwater samples were collected for laboratory analysis [77] (Figure 6).

Soil samples for PCB laboratory analysis were collected from shallow (6"-12") and subsurface (18"-24") depths. PCBs (1.21 mg/kg to 91 mg/kg) were detected in soil samples from SB-1, SB-2, SB-3, SB-4 and SB-5. The highest levels of PCBs (91 and 67.5 mg/kg) were detected in the soil samples collected from SB-2, which was situated adjacent to the east side of the railroad spur. No PCBs were detected in the scrap metal area located west of the railroad spur [77] (Figures 6,7; Table 4).

Between May 14 and 16, 1996, as part of the CAR Addendum, further assessment activities were conducted in the area of free phase oil and PCB contamination. Seven additional soil borings (SB-11 to SB-17) were conducted. A new monitor well (MW-9) was installed near the SB-2 location. In addition, two sediment samples from the excavation pond bank (Pond Bank 1 & 2) were collected. A sample of hydraulic oil was collected for comparison (chromatogram) purposes. The soil samples from the borings were collected from 6-inches and 24 inches bls. The soil samples from borings SB-11 to SB-16 were analyzed for PCBs (EPA Method 8080) only. The soil samples from boring SB-17 and the sediment samples were subjected to Total Petroleum Hydrocarbon [TPH] (EPA Method 8015) analyses. TPH analysis was also performed on the hydraulic oil sample. Groundwater samples were collected from newly installed monitor well MW-9 and existing well MW-4 for PCB analysis [80] (Figure 7).

PCBs were detected in the soil samples (surface soil/subsurface soil samples) collected from SB-11 (38 ug/kg/no detect [ND]), SB-12 (ND/61ug/kg), SB-13 (416 ug/kg/339 ug/kg), SB-14 (100 ug/kg/ND) and SB-16 (570 ug/kg/ND). The highest levels of PCBs were centered on the SB-2 and SB-3 locations. TPHs were detected in sediment samples Pond Bank 1 (24,000 mg/kg) and Pond Bank 2 (430 mg/kg). TPHs (22,000 mg/kg & 15,000 mg/kg) were detected in the soil samples collected from soil boring SB-17. Arochlor 1242 (13.2 ug/l) and arochlor 1254 (2.5 ug/l) were detected in monitor well MW-4. Earth Systems attributed the PCB contamination in MW-4 to suspended sediments. No PCBs were detected, above the detection limit, in the MW-9 groundwater sample [80] (Figure 7).

No petroleum hydrocarbons from the gasoline or kerosene range were reportedly found in the chromatogram analyses of the free phase oil. However, low levels of petroleum hydrocarbons were detected in the motor oil range [80].

On February 11, 1997, Dominion Professional Environmental Geosciences (Dominion), a new environmental consultant, collected 15 soil samples at the Berman

Brothers site. Ten of the samples (SB-18 to SB-21 and SB-27 to SB-32) were collected from 1 foot bls. These samples were analyzed for PCBs (EPA Method 8080). The other five samples (SB-22 to SB-26) were collected at a depth of 6-inches and analyzed for TPHs (EPA Method 3550 [FLO-PRO]). No TPHs were detected above the minimum detection limit. However, PCBs (0.85 to 39 mg/kg) were detected in eight of the ten soil samples. The highest levels were detected in soil samples (SB-27, 28, & 29) located just east of the railroad spur. All eight samples had PCBs in excess of the State residential Soil Cleanup Target Level (SCTL) for PCBs (0.8 mg/kg). Six of the samples exceeded the industrial SCTL (3.8 mg/kg). As part of the assessment, a piezometer (P-1) was installed near the railroad spur. No significant odors or free product were noted [84] (Figure 8).

On September 22, 1997, Dominion submitted soil sample results to FDEP for the Berman Brothers site. Eight additional soil samples (SB-33 to SB-40) were collected on August 18, 1997. The samples were collected between the cast pile and the furnace. Each of the samples was collected from one foot bls and analyzed for PCBs. PCBs were detected in four of the samples (SB-34, 38, 39 & 40) ranging from 2.02 mg/kg (SB-34) to 9.69 mg/kg (SB-39). All four of the PCB concentrations exceed the State residential SCTL for PCBs Three of the samples exceeded the industrial SCTL [34,85] (Figure 9). Based on this and previous sampling activities, two areas of concern, greater than 9 mg/kg of PCBs, were identified. This included the areas on the east side of the railroad spur and west of the furnace [86].

Soil samples were collected by Dominion on June 11, 1998 and July 18, 1998 from fill material deposited at the Berman Brother site. PCBs (7.71 mg/kg to 1,154.4 mg/kg) were detected in thirteen of the twenty-seven soil samples [91].

Between March 18, 1999 and August 20, 1999, Dominion conducted fieldwork for the Supplemental Contamination Assessment of the Berman Brothers site. Twenty-seven borings (SB2, P-1 to P-26) were conducted in the areas of previous transformer activities and free phase oil detection. Soil samples were collected using a Geoprobe Model 5400. A four-foot continuous core barrel with dedicated polystyrene sleeves was employed to collect the soil samples. Soil samples were collected at 0-1 foot bls, 1-2 feet bls and 2-3 feet bls intervals. However, when the water table was shallow, some of the deep soil samples were collected at a shallower depth interval (24-30 inches bls). The soil samples were initially field screened for PCBs using the Triangle Diagnostics PCB On-Site Soil Analysis method. Using this screening method, samples from fourteen of the borings (P-1 to P-3, P-5, P-8, P-11, P-13 to P-20) were determined to contain PCBs greater than 1 mg/kg. In addition, a number of the soil samples had PCBs greater than 10 mg/kg. Soil samples exhibiting field screening levels between 1 mg/kg and 10 mg/kg were collected for PCB laboratory analysis (EPA method 8082) on March 18, 1999, April 2, 1999 and August 20, 1999. Field screening concentrations greater than 10 mg/kg were accepted as valid representations and therefore, not forwarded to the laboratory for analysis. PCBs (0.12 mg/kg to 10.77 mg/kg [P-14]) were detected in a number of the selected soil samples. Areas of contamination, in

excess of the residential and industrial SCTL, were delineated based on both the field screening and laboratory results. These areas of PCB contamination were situated west of the Furnace, east of the railroad spur and south of the Structural Steel Warehouse [94] (Figure 10, Table 5).

On December 17, 1999, as part of the Interim Remedial Action, two additional soil samples (P-27 and P-28) were collected east of the P-25 soil boring location. The samples were collected from 0-1 foot bls and analyzed for PCBs. Arochlor 1016 (.011 mg/kg) and arochlor 1260 (0.007 mg/kg) were detected in the P-28 soil sample. These levels were below the residential SCTL. No PCBs were detected in the P-27 sample [101] (Figure 10, Table 5).

In October 2000, 435 tons of PCB contaminated soil was reportedly removed and transported to Kedesh Inc. in Screven, Georgia for disposal. The excavation was reportedly backfilled with clean fill. Confirmatory soil samples were collected on November 27, 2000. Confirmatory soil samples from the C-1 through C-8 locations were collected between 1-2 feet and 2-3 feet depth intervals. However, when the water table was shallow, some of the soil samples were collected at a shallower depth interval (24-30 inches bls). Soil samples C-7 through C-10 were collected between 0-1 foot bls. PCBs (0.049 to 20.7 mg/kg) were detected in a number of the soil samples. The levels detected in the C-2 (1.03 mg/kg/1-2 feet bls), C-3 (20.7 mg/kg/1-2 feet bls) and C-4 (4.08 mg/kg/1-2 feet bls) locations exceeded the residential SCTL for PCBs. Follow-up soil samples were collected from these locations on February 14, 2001. No PCBs were detected above the detection limit [101] (Figure 11, Table 6).

Groundwater samples were collected from the CGW-1 through CGW-7 well locations on November 7, 2000. The CGW-1, CGW-2, CGW-3 and CGW-7 locations match the locations of former/existing monitor wells MW-1, MW-2, MW-3 and MW-7, respectively. Three of the four existing wells had been destroyed. As a result, for uniformity, new monitor wells were installed using Direct Push Technology (DPT). The wells were constructed of one-inch diameter PVC and installed to the same depth and screen interval as the original wells. No PCBs were detected above the minimum detection limits [101] (Figure 11).

4.0 Ground-Water Pathway

4.1 Regional Hydrogeologic Setting

This site is situated in the Eastern Valley geomorphologic feature of the Northern (proximal) Physiographic Zone of Florida. This area is devoid of karst terrain. Three hydrostratigraphic units exist in the area: the surficial aquifer system, the intermediate aquifer system/confining unit and the Floridan aquifer system [1,8,9,14,15,16].

The surficial aquifer system consists of limestone and sand aquifers in the clayey sand and sandy clay, late Miocene age Hawthorn Group confining beds; the shell, limestone and sand aquifers in the Pliocene or upper Miocene age deposits ("Rock" limestone aquifer) and the sand and shell aquifers in the Pleistocene and Holocene age deposits (surficial sand aquifer). These permeable zones are separated from one another by a number of thin, discontinuous confining beds. The surficial aquifer system sediments are 50 - 100 feet thick in Duval County [8,9,12,14].

The surficial sand aquifer (water-table zone) portion of the surficial aquifer system is composed of tan to yellow, unconsolidated, fine-medium grained quartz sand. These deposits are locally stained rusty brown and red from iron oxide. The deposits may contain thin gray, sandy clay beds, which in some portions of the County contain mollusk shells, particularly near the Atlantic coast. Discontinuous layers of rusty brown hardpan (well indurated iron oxide cemented sand) underlie some of the higher elevations (2-3 feet thick). This water table zone is approximately 25-50 feet thick and the water table is found between 1 and 10 feet below land surface (bls). Recharge to the water table zone is primarily from local rainfall. The water table zone of the surficial aquifer system is used for limited lawn irrigation, stock and domestic uses [8,9,12,14,19].

The Quaternary surficial deposits are underlain by upper Miocene or Pliocene age sediments composed of sand, shell, sandy clay and limestone. These sediments are usually tan, buff or light gray and are differentiated from Hawthorn Group deposits by their lighter colors and lack of phosphate. The lower part of these deposits is composed of tan to yellow, often sandy, porous, bioclastic and cavernous limestone. A few thin beds of brown, crystalline, dolomitic limestone often interbed the limestone. This limestone "Rock" aquifer is commonly 40 to 100 feet bls in Duval County. The "Rock" limestone aquifer is the major water-yielding zone in the surficial aquifer system and is tapped by numerous private and small community supply wells in Duval County. Well yields from the limestone unit average 30 - 100 gallons per minute (gpm) with peaks as high as 200 gpm. This limestone unit is overlain by lower permeability sediments consisting of fine to medium, well sorted sand interbedded with layers of gray-green silty clay, clayey sand and shell. These beds provide an upper semi-confining bed for the "Rock" limestone aquifer. Water level elevations of the water table zone and the limestone unit are similar; however, when water levels in the water table aquifer are higher than those of the limestone unit, a downward potential, albeit small, may exist [8,9,12,14,19].

The upper Miocene or Pliocene deposits are underlain by the middle Miocene age Hawthorn Group. The upper portion of the Hawthorn is composed of gray to blue-green and olive-green clay, sandy clay, and sandy, phosphatic limestone. Abundant, well rounded, polished granules and pebbles of phosphate commonly are present. Some wells tap lenses of sand and limestone in the upper part of the Hawthorn but the Hawthorn is not considered a good source of water [8,9,12,14,18,20].

The surficial aquifer system is underlain by the intermediate aquifer system/confining unit, which is composed of between 250 to 500 feet of phosphatic carbonates, clay, silt, fine-

grained sand and shelly marl of the Hawthorn Group. The Hawthorn Group in Duval County consists of, in descending order, the Coosawhatchie Formation (including the Charlton Member), Marks Head Formation [Fm] and the Penny Farms Fm. Low permeability, silty clay and clay sediments of the Hawthorn provide a confining unit between the surficial aquifer system and the underlying Floridan aquifer system. A coarse to very coarse-grained pebbly sand unit within the Hawthorn is tapped by wells approximately 140 to 165 feet deep. Wells in this zone will yield at least 20 gpm. This permeable unit exists in portions of eastern Duval County (Mayport to Ponte Vedra) [8,9,11,14,15,18,20].

The Floridan aquifer system is the principal source of fresh water in the area and is found under artesian conditions between 500 to 550 feet bls in the metropolitan Jacksonville area. The Floridan aquifer system is composed of limestones, dolomitic limestones and dolomites of Eocene to early Miocene age. The Floridan aquifer system consists of, in ascending order, the Avon Park Fm, the Ocala Limestone and a few discontinuous, thin aquifers in the Hawthorn Group that are hydraulically connected to the rest of the aquifer. The potentiometric surface (May 1990) of the Floridan aquifer system is between 20 to 40 feet above mean sea level (MSL) in eastern Duval County. Regional flow direction within the Floridan aquifer system is to the east-northeast. The City of Jacksonville municipal water supply system is derived from wells that tap the Floridan aquifer system 1,000 to 1,500 feet deep. Due to the considerable thickness and low permeability of the upper Floridan aquifer confining beds and the high potentiometric surface elevation of the Floridan aquifer system, generally no recharge of the Floridan aquifer system takes place in the Jacksonville area [8,9,10,13,14,15,17,18,20,22,23].

4.2 Site Specific Hydrogeologic Setting

As a result of environmental investigations, a number of soil borings have been conducted at this site. The majority of the borings extended to a depth of 17.5 feet. However, one of the borings penetrated to a depth of 36 feet. Clayey sand, black fill was encountered to a depth of about one-foot. Shallow portions of the borings indicate a fine to medium grained tan-white, brownish yellow sand. Iron staining was noted in many of the borings. Clayey sand was encountered between 22 and 32 feet bls in the deep boring. However deeper sections of the boring consisted primarily of medium to coarse grained grayish, tan-brown sand. The water table was encountered between 3 and 4 feet bls. Groundwater flow across the site area was generally to the northwest and north-northwest. However, groundwater flow was determined to be to the east-northeast and northeast during high water table conditions [60,68].

4.3. Ground-Water Targets

The majority of the site area is supplied drinking water by the City of Jacksonville municipal water system. This system is divided into two separate well systems referred to as the North and South Grids. All the municipal wells are open to the Floridan aquifer system. The North Grid service area extends north to Dunn Ave., west to Jones Road,

south to Hipps Road and east to the west side of the St. Johns River. The North Grid well system consists of nine wellfields (47 wells). Three of the wellfields are located within 4 miles of the site. These wellfields include the Main Street (10 wells), Fairfax Ave. (8 wells) and Norwood Ave. (4 wells) water treatment plant (WTP) wellfields. The nearest of these wellfields is the Main Street wellfield located between 1.3 and 1.7 miles south-southwest of the site. These wells range in depth from 1248 to 1303 feet in depth. The North Grid system currently serves 420,989 people. The South Grid consists of six wellfields (24 wells). Four of the wellfields are located within 4 miles of the site. These wellfields include the Arlington (4 wells), Hendricks Ave. (3 wells), Hendricks Ave. Expansion (2 wells) and River Oaks Road (7 wells) water treatment plant (WTP) wellfields. The nearest of these wellfields are the Arlington and Hendricks Avenue Expansion wellfields located between 2.8 and 3.4 miles east-southeast and south, respectively of the site. The South Grid system currently serves 396,461 people [1,10,21,22,23].

A number of community, non-community and small public well systems are used within the grid system for potable use. These well systems collectively serve 31,173 people within 4 miles of the site. The nearest of these systems is the Jacksonville University (JU) well system. JU maintains four Floridan aquifer drinking water wells located between 2.2 and 2.4 miles east of the site. This system currently serves approximately 848 people [1,21]. A number of private wells are employed within the grid system for potable use. The majority of private drinking water wells and a few small size public well system wells are open to the Limestone "Rock aquifer" portion of the surficial aquifer system. These wells are generally open between 40-100 feet bls. A breakdown of the community/noncommunity, municipal and private well systems, by distance, is presented in Table 7.

4.4 Ground-Water Conclusions

PCB and free phase hydraulic oil contamination has been documented at this site. However, elevated levels of heavy metals, in particular lead, may be present in percentage concentrations in site soils near the former lead smelter. If so, lead contamination to the surficial aquifer system is likely. A number of public drinking water wells are located in the site area. Based on these facts, the groundwater migration pathway is a pathway of concern at this site.

5.0. Surface Water Pathway

5.1 Hydrology

Soils at the site are classified as either Arents, Leon-Urban Land Complex or Pottsburg Fine Sands. Arents and Leon-Urban Land Complex soils have been reworked by manmade activities. Arents are poorly drained soils and consist of various shades of gray, brown and red fine sand, sandy loam and sandy clay loam. These soils are present in the northern and central portions of the site. The Leon Fine sand portion of the Leon-Urban Land complex series is found in lawns, vacant lots or playgrounds. The Urban Land portion consists of

areas covered by impervious surfaces (driveways, buildings, parking lots, etc). The Leon-Urban Land Complex occupies the central and southern portions of the site. The Pottsburg Fine Sand consists of poorly drained, gray, brown to grayish-brown fine sand. This unit is present in the southern portion of the site [35].

The site is relatively flat and situated 20 to 22 feet above National Geodetic Vertical Datum (NGVD). The site is located outside of the 500-year floodplain. The majority of the stormwater runoff reportedly flows northwest to southeast across the site and is reportedly conveyed to Long Branch. Long Branch is an east to northeast flowing tributary of the St. Johns River, located approximately 3,000 feet north of the site. The St. Johns River is located about 1.25 miles northeast of the site [1,24,60,68] (Figure 1).

The St. Johns River evolved from a lagoon that was formerly enclosed by a barrier which remains in relict form as the Atlantic Coastal Ridge. The St. Johns River is a flat, meandering river that discharges into the Atlantic Ocean near Mayport. This portion of the St. Johns River is a tidally influenced, high salinity, estuarine water body. The net flow of the St. Johns River, near the probable point of entry (PPE), is downstream to the Atlantic Ocean. However, due to tidal cycles, flow reversals do occur (approximately 30% of the time). The Atlantic Ocean is located more than 20 miles downstream of the confluence of Long Branch and the St. Johns River [1,26,31,40] (Figures 1,2).

5.2 Surface Water Targets

No drinking water surface water intakes are located along the surface water migration pathway [10,22]. No major fisheries exist in Long Branch. However, some recreational "cane pole" fishing may take place. The St. Johns River is utilized for commercial and recreational fishing. Blueback herring, Hickory shad and American shad are commercially harvested from St. Johns River waters [26]. An estimated 7,845,692 pounds of finfish, shellfish and shrimp were harvested from Duval County marine and estuarine waters during 1990 [25].

The St. Johns River is a federally designated critical habitat for the endangered West Indian manatee [26,27,28]. Two manatee aggregation areas (overwintering areas) are located near the confluence of Long Branch and the St. Johns River. These aggregation areas are located near warm water discharge points to the River [26,27,30,31]. In addition, this portion of the St. Johns River is a migratory area for the federally designated endangered shortnose sturgeon. Bald eagle (federally threatened species) and Red-cockaded woodpecker (federally endangered species) nests have also been identified along this portion of the St. Johns River [27,31,36]. This portion of the river is also a nesting area for the American oystercatcher (State Species of Special Concern [SSC]) and a breeding/nursery area for shrimp and crab [27,31].

5.3 Surface Water Pathway Conclusions

As detailed earlier, heavy metal soil contamination, as a result of former lead smelting activities, may exist at this site. Given this scenario, it is possible that heavy metals, particularly lead, may have been transported to downstream water bodies. A number of fisheries and sensitive environments have been identified in the St. Johns River watershed. Further evaluation of this pathway is warranted.

6.0 Soil Exposure and Air Migration Pathways

6.1 Physical Conditions

The Berman Brothers Inc. property consists of a warehouse (structural steel and pipe storage), the Crane Building and a furnace. Scrap metal processing and materials storage is conducted in the northern part of the property. Ferrous metal recovery and processing is conducted in the southwest portion of the property at the Motor Assembly (Shear House) area and metal shredder. A least one railroad spur is present on the site. A number of metal scrap piles were observed during the April 2002 windshield survey. The site is partially fenced. However, site access is not restricted [60,68,109] (Figures 3-8).

6.2 Soil and Air Migration Targets

A small worker population likely exists on-site. However, no residential population or terrestrial sensitive environments are reported on-site [1,30,109]. However, a number of abandoned homes were identified near the site during the windshield survey. It is currently unclear why the homes were abandoned. The Jacksonville area is heavily populated. The City of Jacksonville has a population density of 837.3 people per square mile [29]. Based on 2000 Tiger Database Census data, there are 139,695 people living within 4 miles of the site [41]. A number of sensitive environments have been identified within 4 miles of the site. (Please refer to the Surface Water Targets Section (Section 5.2) for those sensitive environments).

6.3 Soil Exposure and Air Pathway Conclusions

No residents or terrestrial sensitive environments exist on-site. However, further inquiry regarding the abandoned homes near the site should be conducted. As a result, the soil exposure pathway may be a concern at this site. A large population and a number of sensitive environments exist within 4 miles of the site. However, no air releases have been reported to date. Therefore, the air migration pathway does not appear to be a major concern at this time.

7.0 Summary and Conclusions

The Florida Smelting Co. aka Berman Brothers site is located at 2726 Evergreen Avenue, Jacksonville, Duval County, Florida. The Florida Smelting Co. (FSC) began operating in

1940 and since the beginning of its operations has been known to have another address of 18^{th} Street and Evergreen. FSC operated at the 2726 Evergreen Avenue location until at least 1946, when the site became Albright and Company, Junk. In 1950, it appears that FSC began operations at another facility at 5800 Buffalo Avenue. Berman Brothers Incorporated, a scrap metal processor, currently occupies the site and has owned the property since 1965.

FSC reportedly performed lead smelting. Site file information indicates that FSC used batteries as a primary feedstock for lead. The site file also indicates that a scrap yard existed at this site since the 1930's. It is reported that ferrous and non-ferrous processing operations have been conducted in the northern portion of the site throughout its history. A metal compacting machine, which was hydraulically powered, was formerly located at the site. As a result, other sources of scrap lead were likely used at the site.

The typical secondary smelting process involved lead scrap and lead components from used car batteries. The lead posts and grids were recovered from the batteries for smelting. The smelter operation typically consisted of reverberatory or blast furnaces, which were used to produce soft pure lead or specialty alloys. As part of the refining process, some smelting operations introduced antimony, arsenic and cadmium for the desired product. The furnaces were periodically opened to remove slag (60-70% lead) and a soft pure lead product. Studies at other former secondary lead smelting sites indicate that lead concentrations in surface soils may exceed 1% near the smelters. A study of soils at eight former secondary smelting facilities in Baltimore and Philadelphia indicated lead concentrations ranging from 306 mg/kg to 2,550 mg/kg. EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) have identified lead as the leading priority contaminant at Superfund sites. Both EPA and ATSDR consider lead a serious public health problem, particularly in children.

The operations at Berman Brothers, Inc. consists of non-ferrous scrap processing of copper, brass, aluminum lead, stainless steel and ferrous scrap processing and storage of new structural steel and piping supplies. Approximately 60% of the scrap operation involves new steel. However, a smelting furnace is used for aluminum and zinc extraction. The dross is reportedly stockpiled adjacent to the building. It is currently unclear whether this furnace is the same as the one used by FSC. Hundreds of transformers from the Jacksonville Electric Authority (JEA) were stored on site. This portion of the site was reportedly leased from the Jacksonville Port Authority (JPA). The oils in the transformers, which contained Polychlorinated Biphenyls (PCBs), were removed and placed into two on-site tanks (10,000 gallon and 6,000 gallon capacity). Numerous spills were reported to have occurred as a result of these activities. The owner reported that most of the oil was sold.

Various contamination assessment investigations at the site confirmed both hydraulic oil and PCB contamination of site soils and groundwater. However, only a limited number of heavy metal analyses were conducted. A number of soil excavation and disposal activities

reportedly occurred at this site. However, documentation of the ultimate disposition of the excavated PCB soils has not been provided to FDEP.

Elevated levels of heavy metals, in particular lead, may be present in percentage concentrations in site soils near the former lead smelter. If so, lead contamination to the surficial aquifer system is likely. A number of public drinking water wells are located in the site area. Based on these facts, the groundwater migration pathway is a pathway of concern at this site.

As detailed earlier, heavy metal soil contamination, as a result of former lead smelting activities, may exist at this site. Given this scenario, it is possible that heavy metals, particularly lead, may have been transported to downstream water bodies. A number of fisheries and sensitive environments have been identified in the St. Johns River watershed. Further evaluation of this pathway is warranted.

No residents or terrestrial sensitive environments exist on-site. However, further inquiry regarding the abandoned homes near the site should be conducted. As a result, the soil exposure pathway may be a concern at this site. A large population and a number of sensitive environments exist within 4 miles of the site. However, no air releases have been reported to date. Therefore, the air migration pathway does not appear to be a major concern at this time.

Based on past activities at this site, the likely presence of contaminated soil and groundwater and the proximity of the site to public drinking water wells, further CERCLA action is warranted at this site on a high priority basis. Therefore a Site Inspection (SI) is recommended for this site.

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SITE LOCATION MAP

Florida Smelting Co.

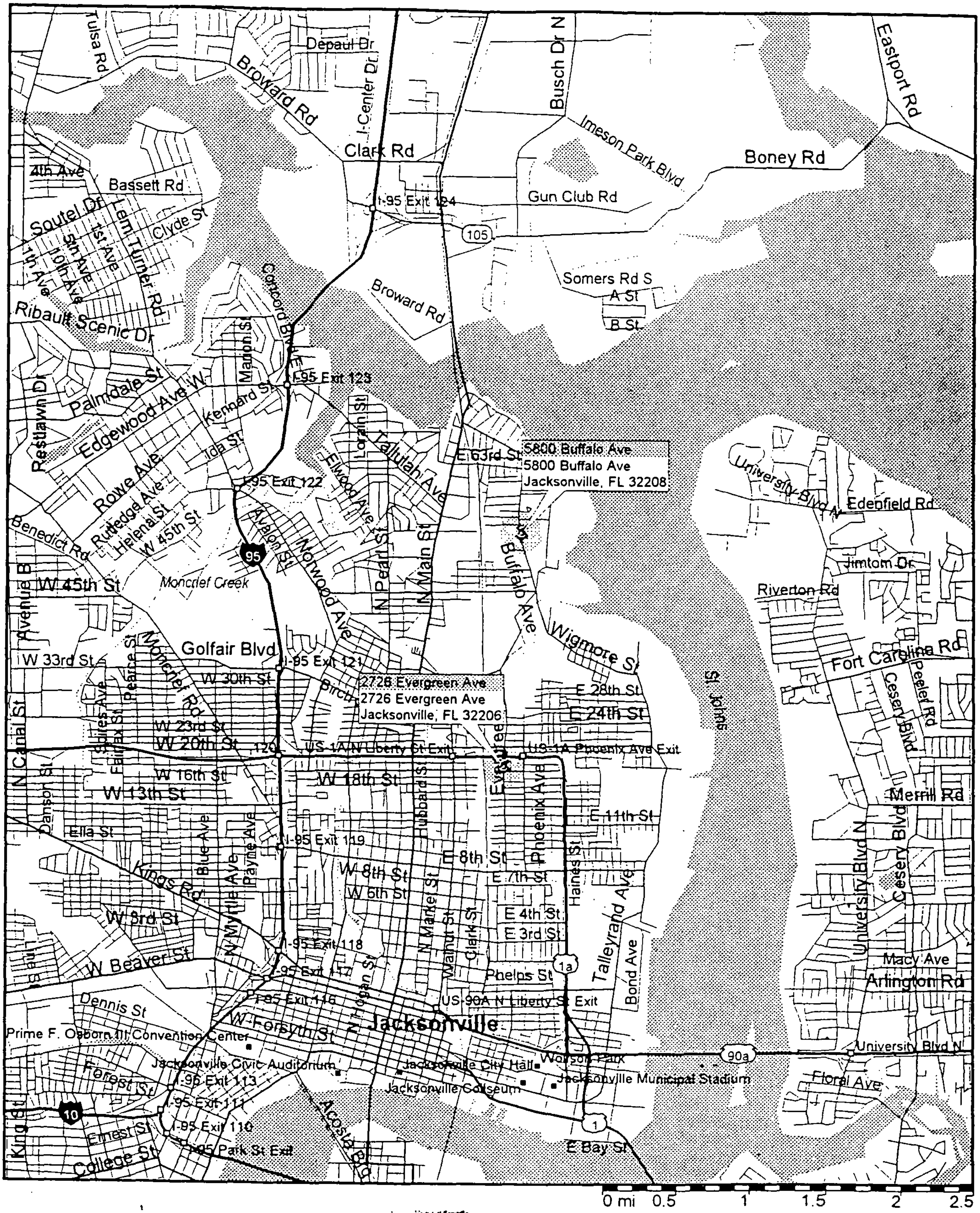
Aka Berman Brothers

Jacksonville, Duval County, Florida

USGS **Jacksonville, Fla 1964 (PR 1982)**

Figure 1

Lead Sites



Streets98

Figure 2

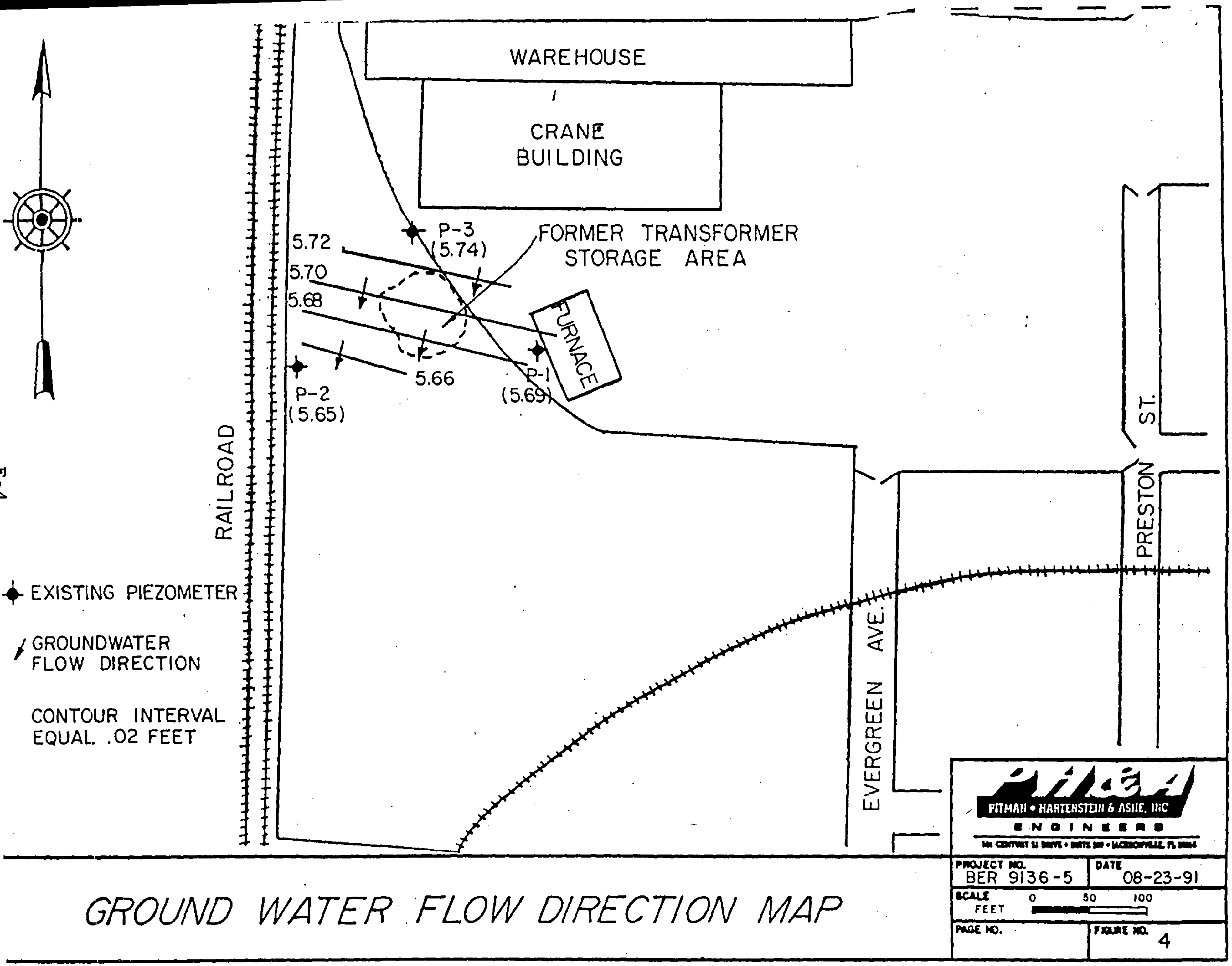
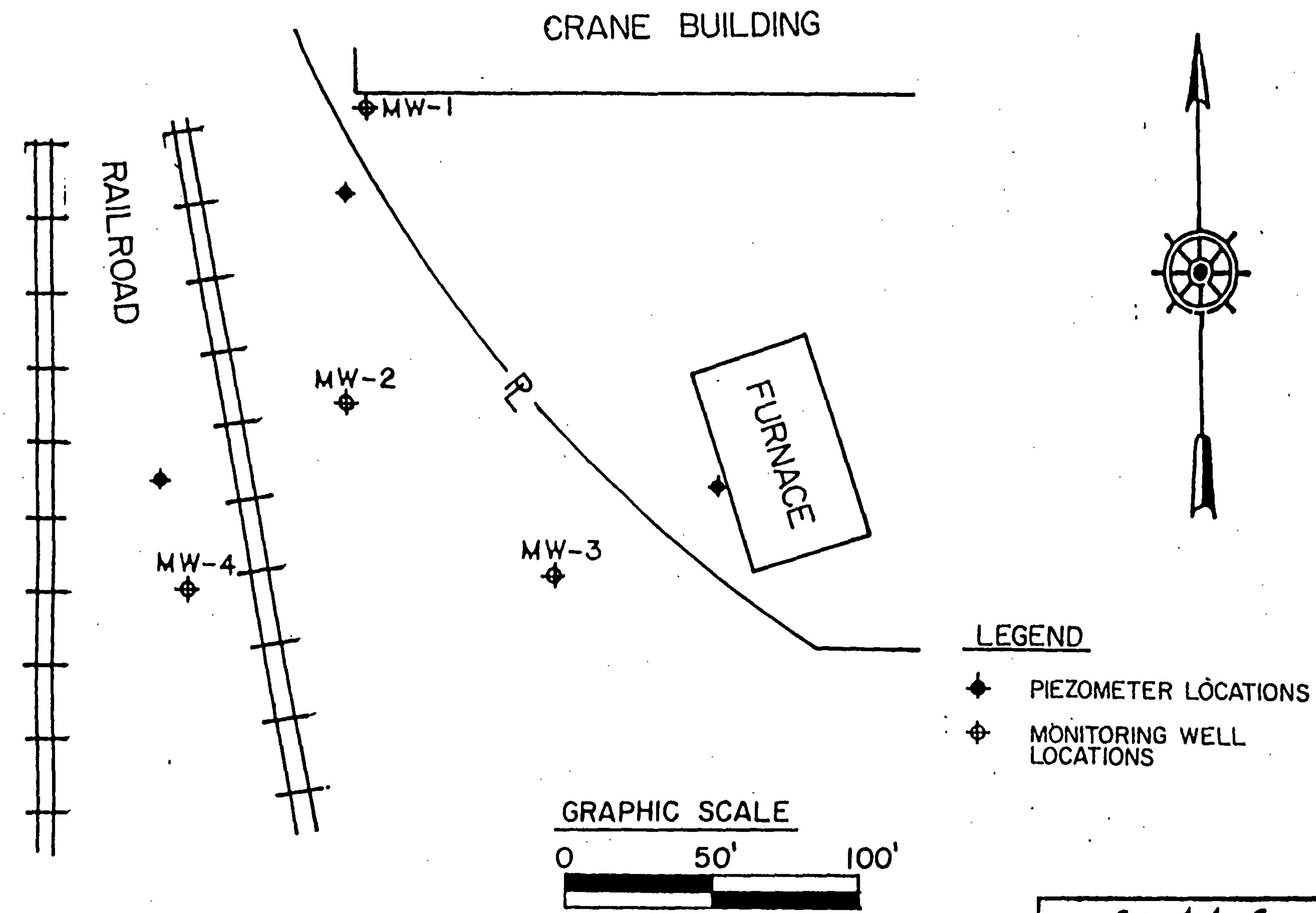

WAREHOUSE
CRANE BUILDING
FORMER TRANSFORMER STORAGE AREA
FURNACE
P-3 (5.74)
P-1 (5.69)
P-2 (5.65)
5.72
5.70
5.68
5.66
RAILROAD
EVERGREEN AVE.
PRESTON ST.
EXISTING PIEZOMETER
GROUNDWATER FLOW DIRECTION
CONTOUR INTERVAL EQUAL .02 FEET
PITMAN • HARTENSTEIN & ASHE, INC
ENGINEERS
PROJECT NO. BER 9136-5
DATE 08-23-91
SCALE FEET 0 50 100
PAGE NO.
FIGURE NO. 4
GROUND WATER FLOW DIRECTION MAP

Figure 3

F-4



GROUNDWATER MONITORING WELL AND SOIL SAMPLING LOCATION MAP

ENGINEERS

PROJECT NO.	DATE
BER 9136-5	01-24-92
SCALE 1" = 50'	
PAGE NO.	FIGURE NO. 5

Figure 4

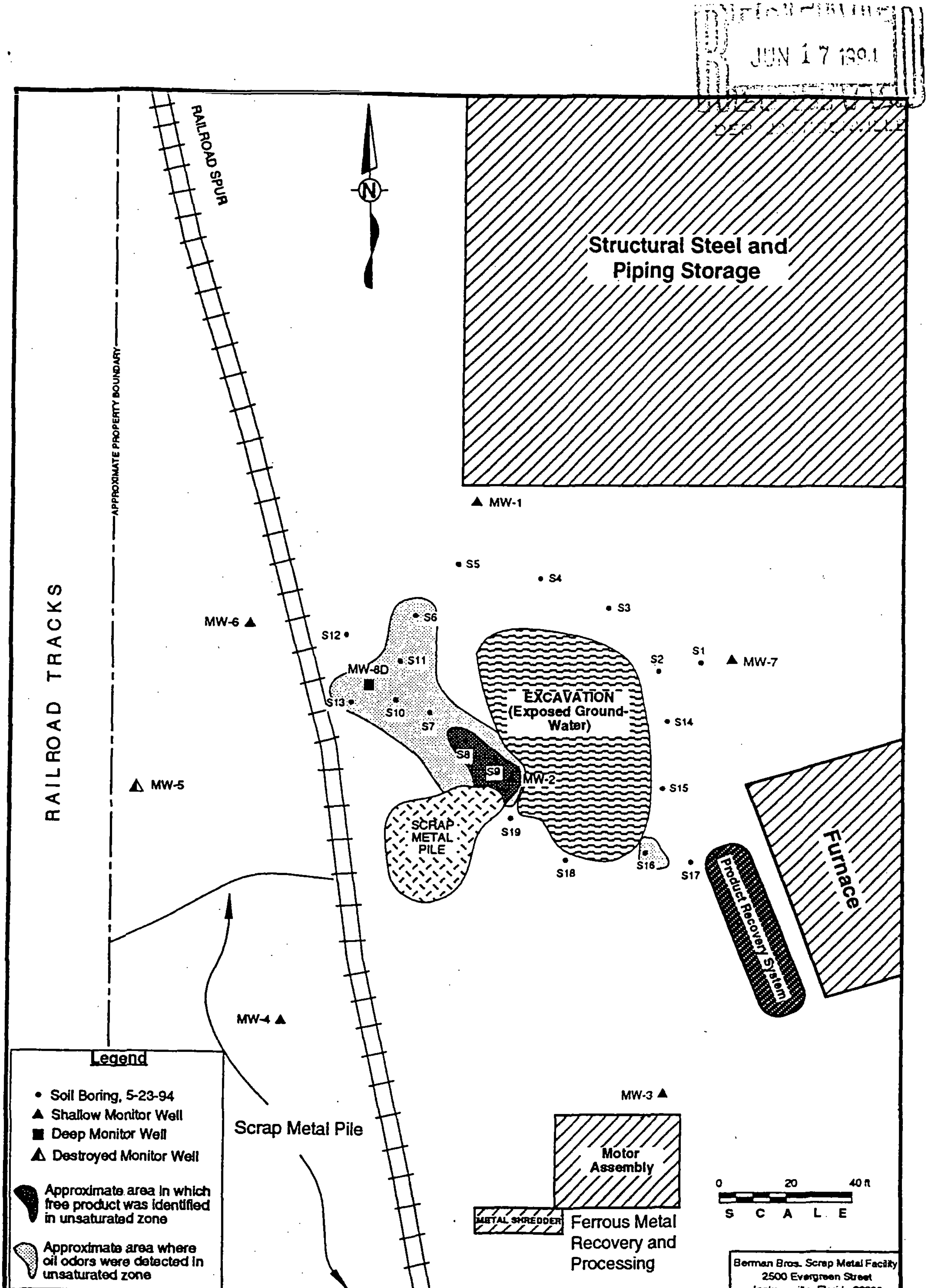


Figure 2. Results of Qualitative Soil Survey Conducted May 23, 1994

Figure 5 *EARTH SYSTEMS*

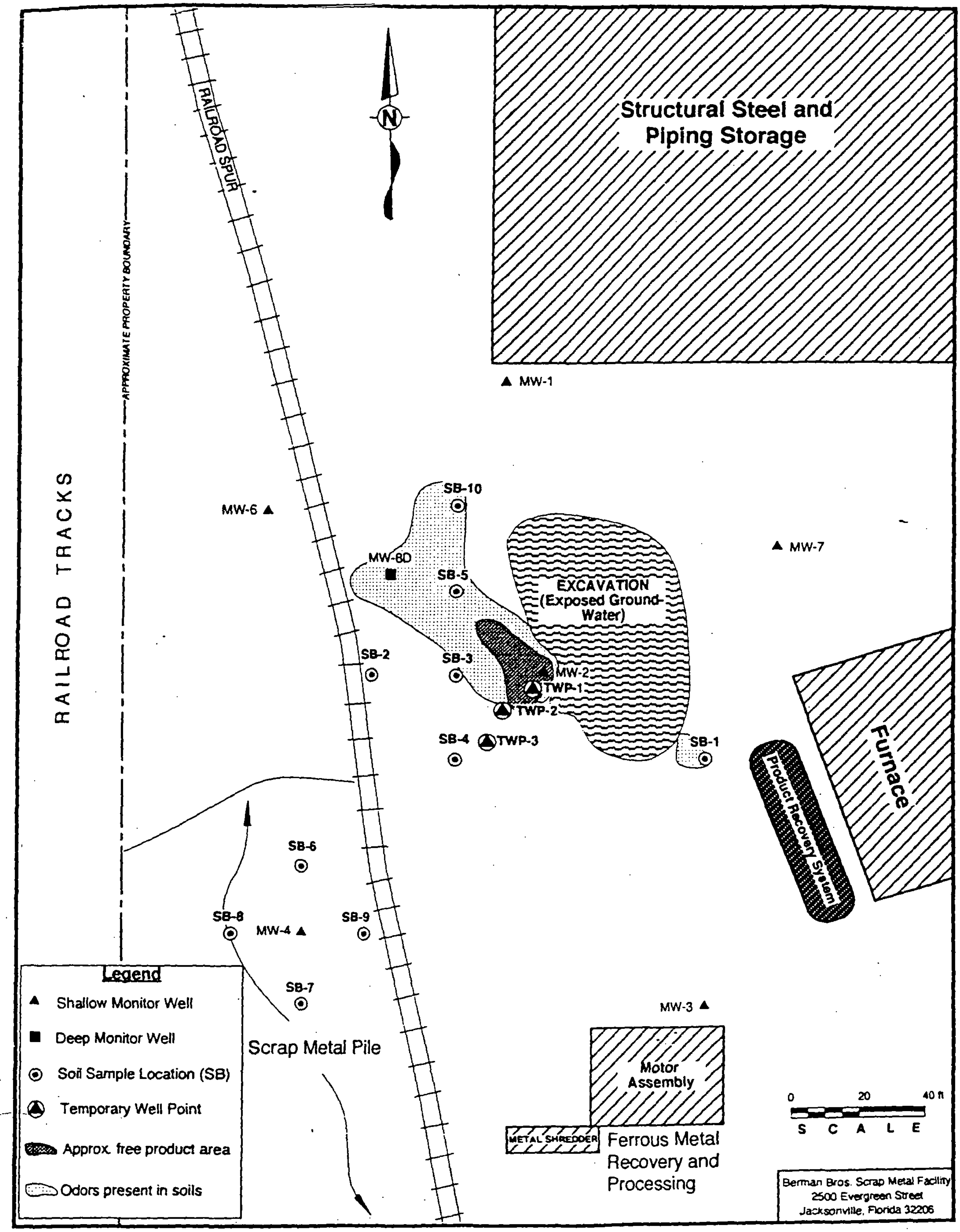


Figure 1. Site Map Showing of Soil Sampling Locations and Shallow Well Points

Figure 6 *EARTH SYSTEMS*

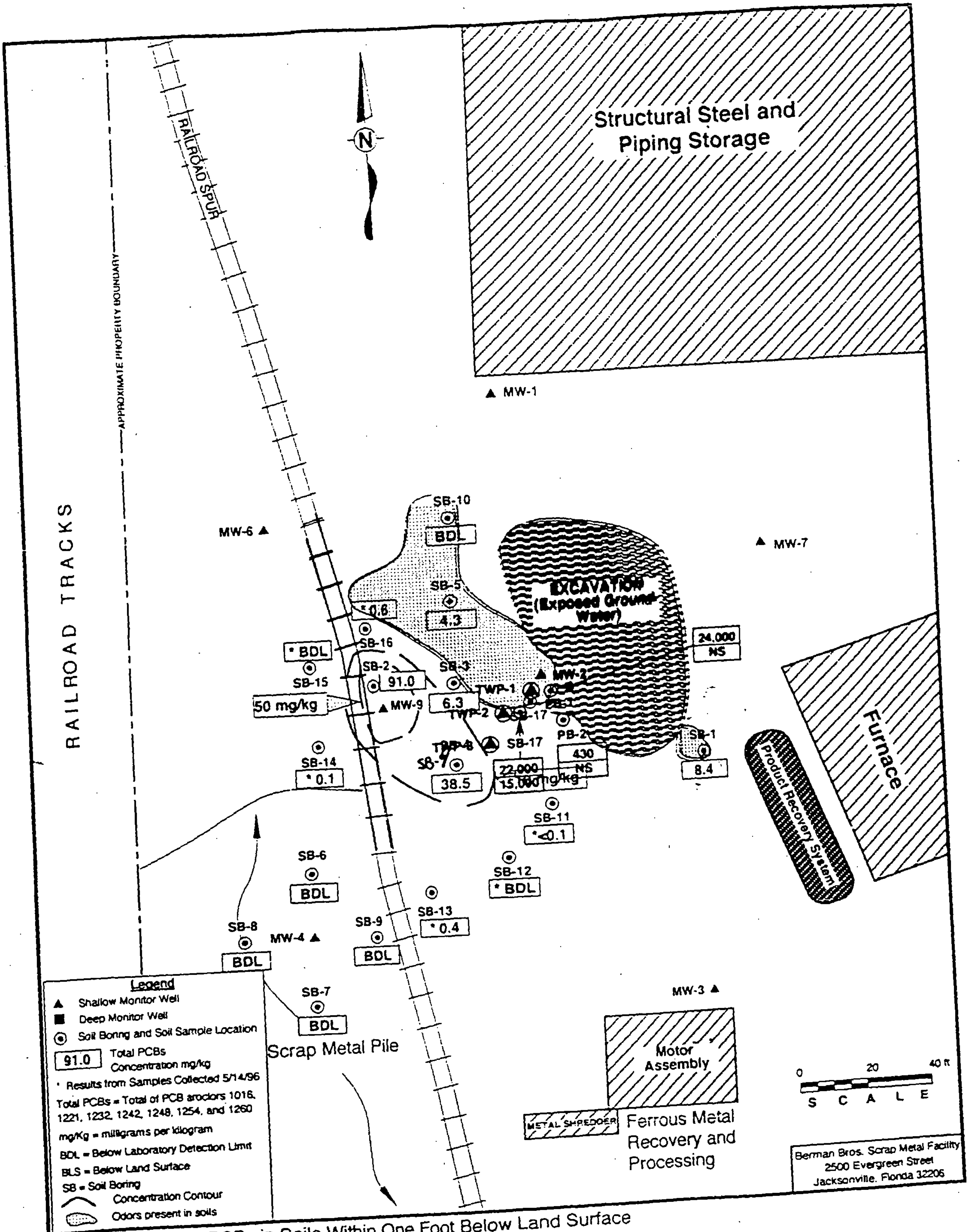


Figure 1. Extent of PCBs in Soils Within One Foot Below Land Surface

EARTH SYSTEMS

Figure 7

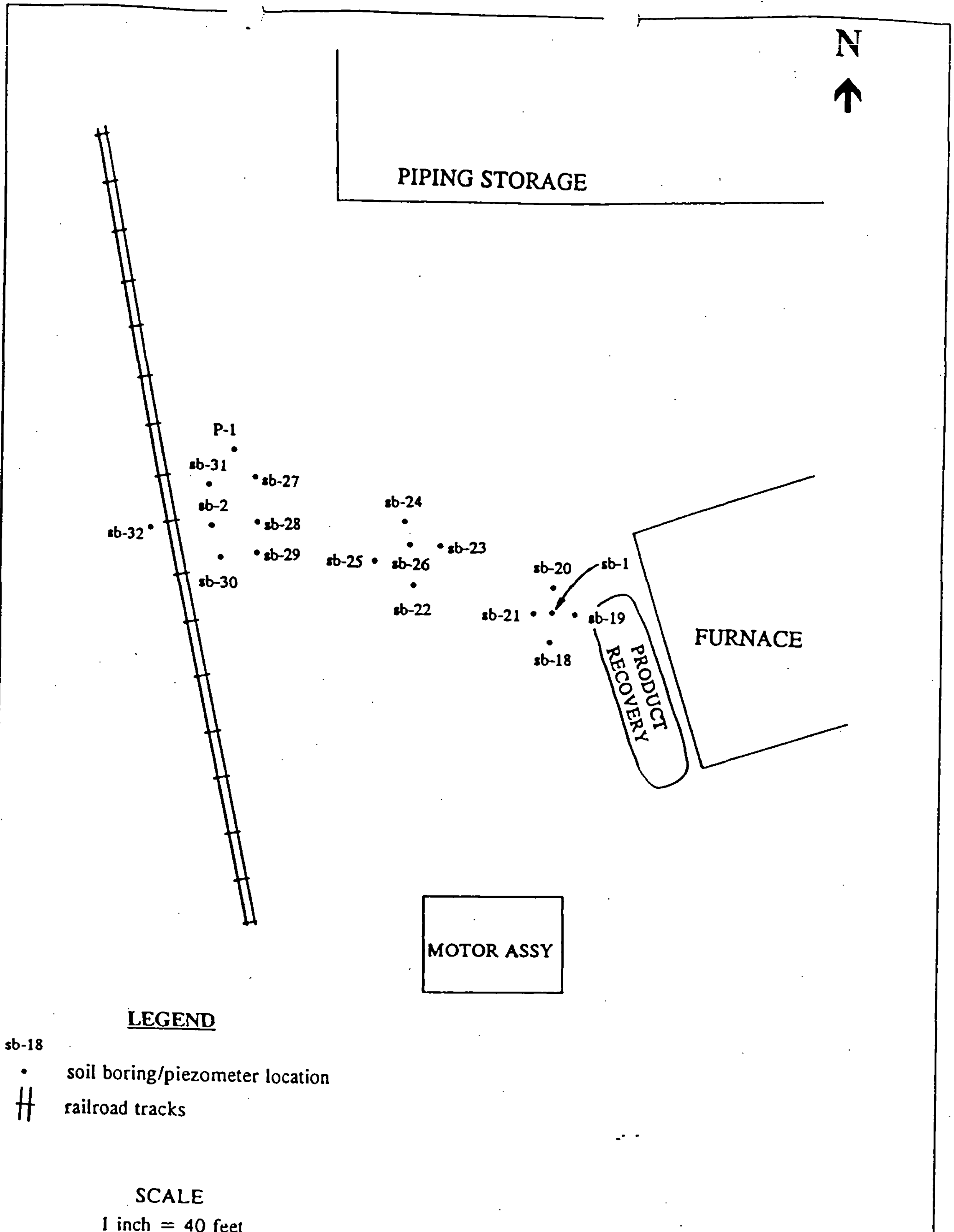


FIGURE 1. Soil Boring Locations	BERMAN BROTHERS 2500 Evergreen Avenue Jacksonville, Florida	DOMINION 6924 Hanson Drive South Jacksonville, FL 32210 (904) 783-4279

Figure 8

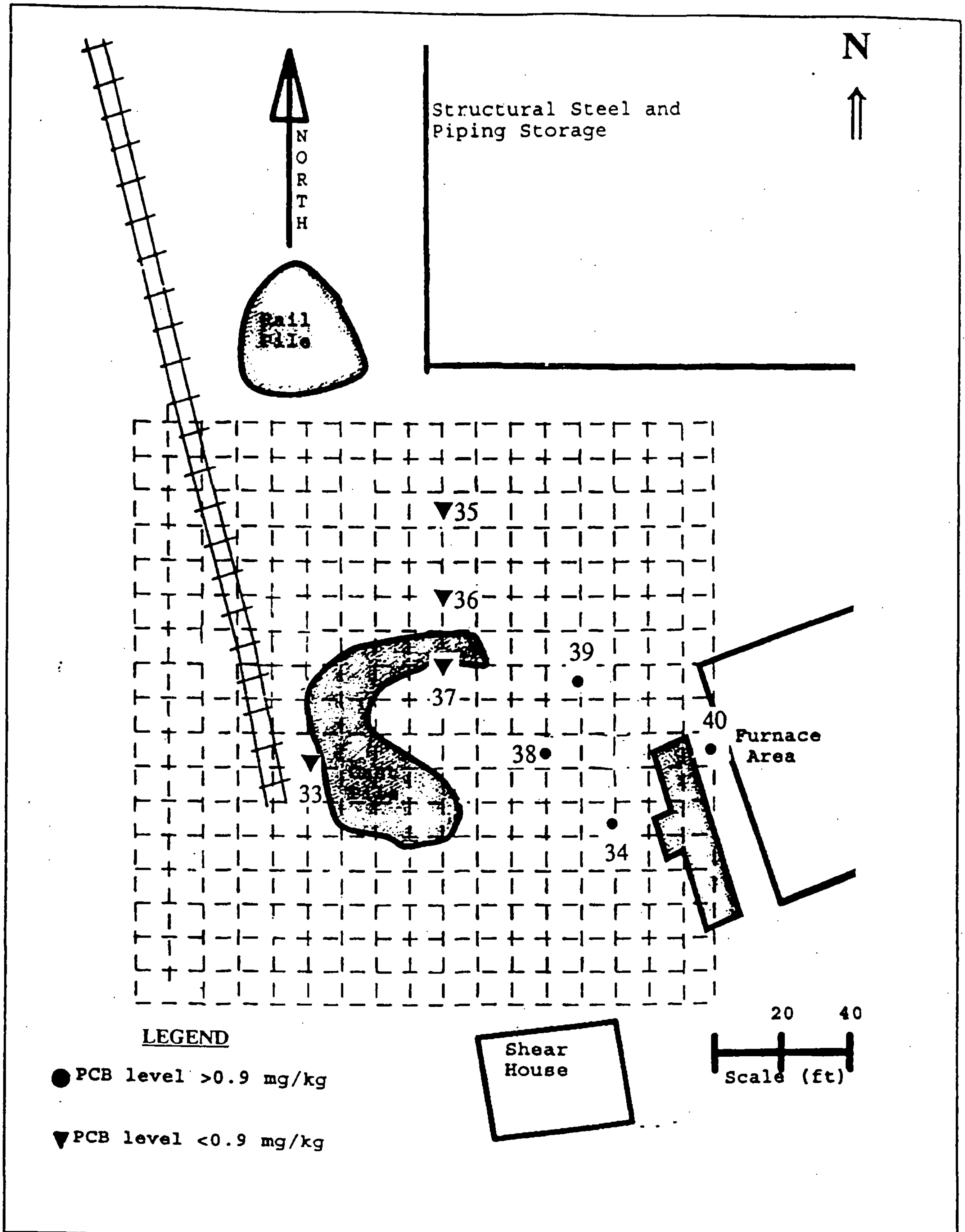


FIGURE 1. Soil Sample Locations	BERMAN BROTHERS 2500 Evergreen Avenue Jacksonville, Florida	DOMINION 6924 Hanson Drive South Jacksonville, FL 32210 (904) 783-4279

Figure 9

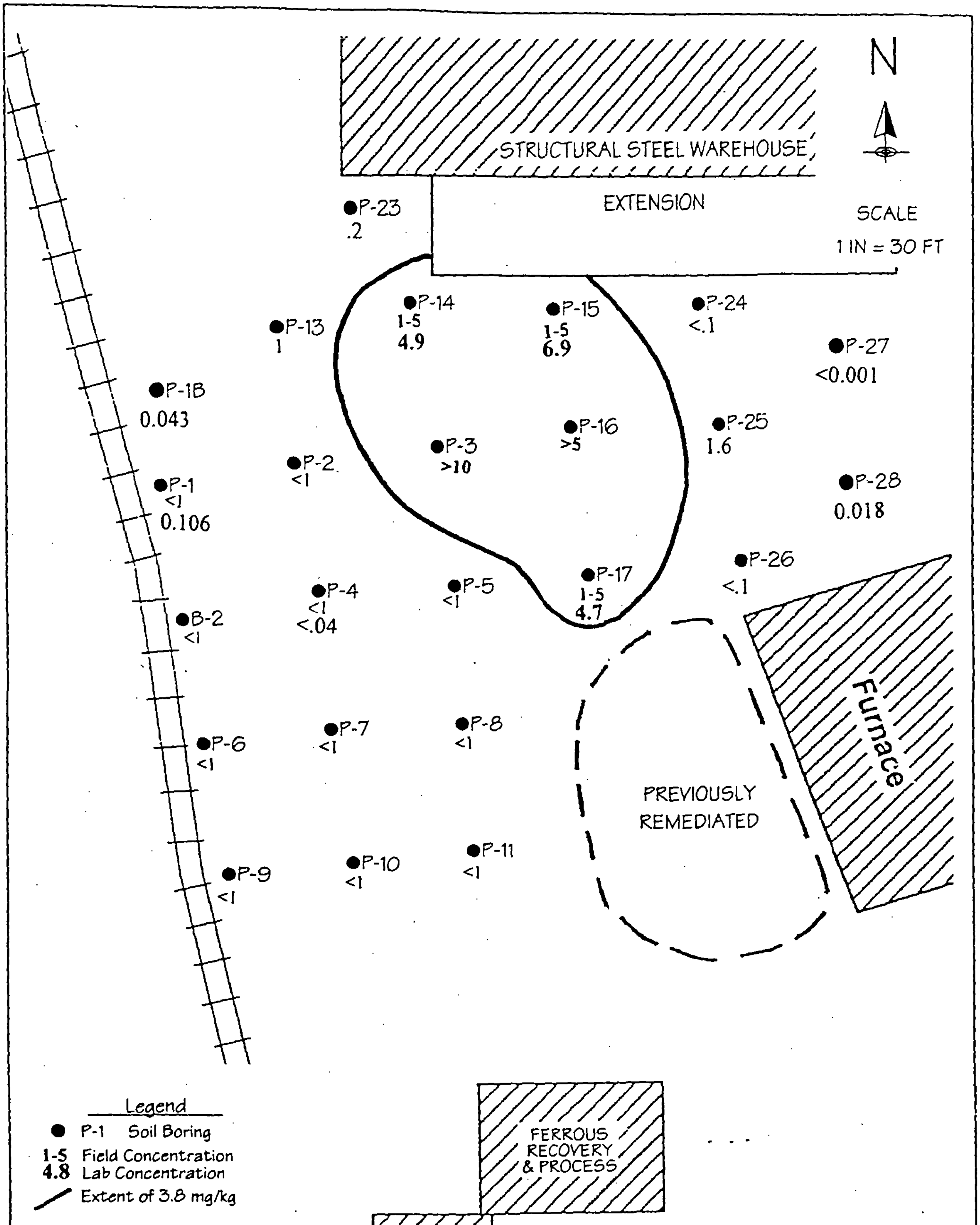


FIGURE 1. PCB Levels in Soils from 0-1 ft Below Land Surface.	BERMAN BROTHERS 2500 Evergreen Avenue Jacksonville, Florida	DOMINION 6924 Hanson Dr S Jacksonville, FL 32210 (904) 783-4279

Figure 10

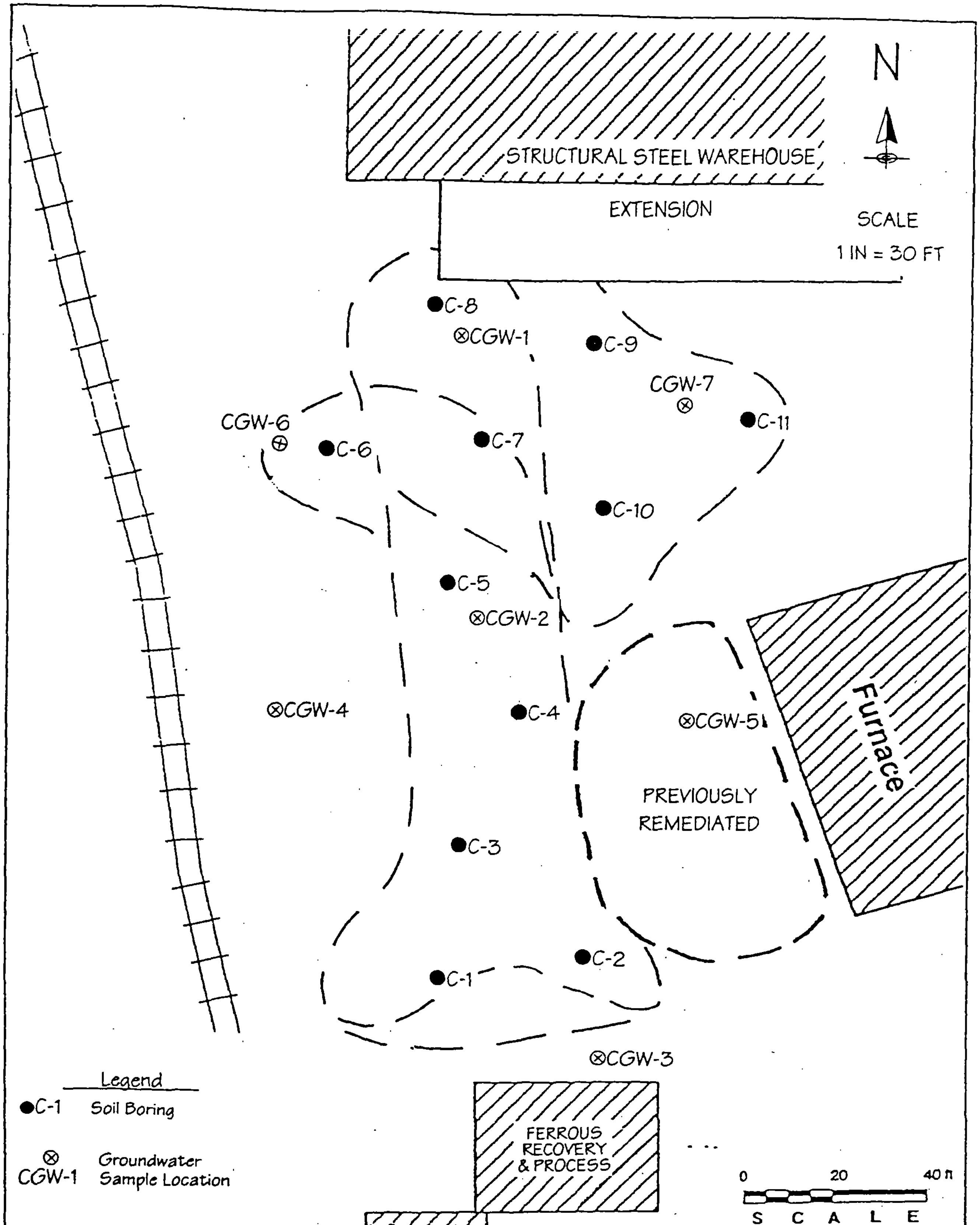


FIGURE 4. Proposed Confirmatory Soil and Groundwater Sampling Location

BERMAN BROTHERS
2500 Evergreen Avenue
Jacksonville, Florida

DOMINION
6924 Hanson Dr S
Jacksonville, FL 32210
(904) 783-4279

Figure 11

TABLE 4 - GROUND WATER ANALYTICAL RESULTS SUMMARY

PARAMETER	Unit	MW-1	MW-2	MW-3	MW-4	Standard
Initial Sampling Event:						
PCBs	UG/L	<0.7	5.0	<0.7	10.0	PQL(1)
Barium	MG/L	0.096	0.446	0.204	0.095	1.00(2)
Lead	MG/L	0.483	0.065	0.525	0.044	0.05(2)
Second Sampling Event:						
PCBs	UG/L	NA	<0.65	NA	<0.65	PQL(1)
Lead(3)	MG/L	<0.025	<0.025	<0.025	NA	0.05(2)

UG/L = Micrograms per liter or parts per billion (ppb).

MG/L = Milligrams per liter or parts per million (ppm).

NA = Not analyzed.

Notes:

(1) PQL = Practical Quantitation Limit as listed in the document *Ground Water Guidance Concentrations*, Florida Department of Environmental Regulation, Division of Water Facilities, Bureau of Ground Water Protection, February 1989.

(2) Primary drinking water standard.

(3) Unfiltered fraction.

Table 5. Soil Sample Analytical Results
2500 Evergreen Avenue
Jacksonville, FL

Well Boring	Highest Net OVA-FID Result (ppm)	RCRA Metals (mg/kg) Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Lead	Selenium	PCBs (EPA Method 8080)							Polynuclear Aromatics (PAHs) EPA Method 8310 (µg/kg) Total Naphthalenes	Other PAHs
INTEGRATED ENVIRONMENTAL SOLUTIONS (12/3/91)										Total PCBs (mg/kg)								
MW-1	NM	<1.0	<1.0	1.08	<1.0	<1.0	<0.5	<1.0	<1.0	<0.1							NA	NA
MW-2	NM	<1.0	<1.0	5.10	<1.0	<1.0	<0.5	7.60	<1.0	5.0							NA	NA
MW-3	NM	<1.0	<1.0	5.14	<1.0	1.16	<0.5	40.80	<1.0	0.4							NA	NA
MW-4	NM	<1.0	<1.0	1.78	<1.0	<1.0	<0.5	2.90	<1.0	3.0							NA	NA
EARTH SYSTEMS (6/12/92)										Total PCBs (µg/kg)								
										Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260		
SS-1	NM	NA	NA	NA	NA	NA	NA	NA	NA	<370	<370	<370	<370	8000	<370	<370	76	267
EARTH SYSTEMS (9/14/93)																		
MW-6	0	<1	<5	3	<0.5	3	<0.1	<5	<10	<40	<40	<40	<40	<40	54	<50	ND	ND
MW-8D	4	<1	<5	4	<0.5	3	<0.1	<5	<10	<41	<41	<41	<41	54	<41	<41	ND	ND

ND = None Detected
NM = Not Measured
NA = Not Analyzed

Samples were composited from land surface to soil/water interface (approximately 3 ft bls).

Table 2

Table 6. Ground-Water Analytical Results
2500 Evergreen Avenue
Jacksonville, FL

Sampling Performed by Integrated Environmental Solutions											
		RCRA Metals (mg/L)									Total PCBs (µg/L)
								Lead			
Well ID	Sampling Date	Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Unfiltered	Filtered	Selenium	
MW-1	12/4/91	<.025	<.025	0.096	<.025	<.025	<.005	0.483	---	<.025	<0.7
	1/9/92	---	---	---	---	---	---	<.025	<.025	---	---
MW-2	12/4/91	<.025	<.025	0.446	<.025	<.025	<.005	0.065	<.025	<.025	5.0
	1/9/92	---	---	---	---	---	---	<.025	<.025	---	<.65
MW-3	12/4/91	<.025	<.025	0.204	<.025	<.025	<.005	0.525	---	<.025	<0.7
	1/9/92	---	---	---	---	---	---	<.025	<.025	---	---
MW-4	12/4/91	<.025	<.025	0.095	<.025	<.025	<.005	0.044	---	<.025	10.0
	1/9/92	---	---	---	---	---	---	---	---	---	<.65

Sampling Performed by Earth Systems											
		PCBs (µg/L)								Method 610 Parameters (µg/L)	
Well ID	Sampling Date	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total PCBs	Total Naphthalenes	Other PAHs
MW-1	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND
MW-2	11/2/93	---	---	---	---	---	---	---	---	---	---
MW-3	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND
MW-4	11/2/93	<1	<2	<1	250	<1	<1	11	261	ND	ND
	2/4/94	<1	<2	<1	200	<1	<1	8.2	208.2	---	---
	Filtered	<1	<2	<1	<1	<1	<1	<1	ND	---	---
MW-5	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND
MW-6	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND
MW-7	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND
MW-8D	11/2/93	<1	<2	<1	<1	<1	<1	<1	ND	ND	ND

--- = Not sampled
ND = None Detected

EARTH SYSTEMS

Table 3

Table 1 Total PCBs in Soil Borings
Berman Brothers Scrap Metal Facility
2500 Evergreen Street
Jacksonville, Florida

Soil Boring	Date of Sampling	Sample Depth	Total PCBs (mg/Kg)
SB-1	10/12/96	6" - 12"	8.40
		18" - 24"	1.21
SB-2	10/12/96	6" - 12"	91.00
		18" - 24"	67.50
SB-3	10/12/96	6" - 12"	6.25
		18" - 24"	16.20
SB-4	10/12/96	6" - 12"	38.50
		18" - 24"	5.63
SB-5	10/12/96	6" - 12"	4.32
		18" - 24"	BDL
SB-6	2/21/96	6" - 12"	BDL
		18" - 24"	BDL
SB-7	2/21/96	6" - 12"	BDL
		18" - 24"	BDL
SB-8	2/21/96	6" - 12"	BDL
		18" - 24"	BDL
SB-9	2/21/96	6" - 12"	BDL
		18" - 24"	BDL
SB-10	2/21/96	6" - 12"	BDL
		18" - 24"	BDL

mg/Kg - Milligram per kilogram
BDL - Below Laboratory Detection Limit
Total PCBs - Total of PCB aroclors 1016, 1221, 1232, 1242, 1254, and 1261

Table 4

Table 1. Pre-Remediation PCB Levels (mg/kg) in Soil

Sample Location	Sample Date	Vertical Interval 0-1 ft		1-2 ft		2-3 ft	
		Field	Lab	Field	Lab	Field	Lab
P-1	3/18/99	<1	0.106 (12/17/99)	<1	ND	<1	ND
P-2	3/18/99	<1	ND	<1	ND	**1-5**	**5.95**
P-3	3/18/99	**>10**	ND	**>10**	ND	**1-5**	**4.79**
P-4	3/18/99	<1	<0.04	<1	ND	<1	ND
P-5	3/18/99	<1	ND	**>10**	ND	**~10**	ND
P-6	3/18/99	<1	ND	<1	ND	<1	ND
P-7	3/18/99	<1	ND	<1	ND	<1	ND
P-8	3/18/99	<1	ND	**>10**	ND	**>10**	ND
P-9	3/18/99	<1	ND	<1	ND	<1	ND
P-10	3/18/99	<1	ND	<1	ND	<1	ND
P-11	3/18/99	<1	ND	**5-10**	ND	**5-10**	ND
P-12	4/2/99	ND	ND	ND	ND	<1	ND
P-13	4/2/99	1	ND	**1-5**	0.85	<1	ND
P-14	4/2/99	**1-5**	**4.85**	**1-5**	**10.77**	<1	ND
P-15	4/2/99	**1-5**	**6.88**	<1	ND	<1	ND
P-16	4/2/99	**>5**	**ND**	**1-5**	**1.72**	**1-5**	**<2**
P-17	4/2/99	**1-5**	**4.7**	<1	ND	<1	ND
P-18	4/2/99	ND	ND	**>5**	ND	**>5**	ND
P-19	4/2/99	ND	ND	**>5**	ND	<1	ND
P-20	4/2/99	ND	ND	**>5**	ND	**>5**	ND
P-21	8/20/99	ND	ND	ND	<0.1	ND	<0.1
P-22	8/20/99	ND	ND	ND	<0.1	ND	<0.1
P-23	8/20/99	ND	0.22	ND	0.12	ND	ND
P-24	8/20/99	ND	<0.1	ND	ND	ND	ND
P-25	8/20/99	ND	**1.61**	ND	<0.1	ND	<0.1
P-26	8/20/99	ND	<0.1	ND	ND	ND	ND
P-27	12/17/99	ND	<0.001	ND	ND	ND	ND
P-28	12/17/99	ND	0.018	ND	ND	ND	ND

ND - no data

bold indicates that the value is above the residential, direct exposure limit

shaded indicates that the value is above the industrial limit

DOMINION

Table 5

Table 2. Post-Remediation PCB Levels (mg/kg) in Soil

Sample Location	Sample Date	Vertical Interval 0-1 ft	1-2 ft	2-2.5 ft
C-1	11/27/00	ND	0.15	0.153
C-2	11/27/00	ND	**1.03**	1.522
	2/14/1	ND	BDL	ND
C-3	11/27/00	ND	**20.7**	0.042
	2/14/1	ND	BDL	ND
C-4	11/27/00	ND	**4.076**	1.33
	2/14/1	ND	BDL	ND
C-5	11/27/00	ND	0.021	7.4
C-6	11/27/00	ND	ND	0.049
C-7	11/27/00	0.043	BDL	11
C-8	11/27/00	**1.79**	BDL	ND
	2/14/1	BDL	ND	ND
C-9	11/27/00	BDL	ND	ND
C-10	11/27/00	BDL	ND	ND
C-11	11/27/00	ND	ND	ND

ND - no data

BDL - below instrument detection limit

bold indicates that the value is above the residential, direct exposure limit

Table 7
Estimated Number of Potable Wells and Population Served
Florida Smelting Co.
aka: Berman Brothers
Jacksonville, Duval County, Florida
Limestone "Rock" Aquifer/Floridan aquifer system (AOC)

Well Type	0-1/4 mile	1/4-1/2 mile	1/2-1 mile	1-2 miles	2-3 miles	3-4 miles
Municipal[1]	0/0	0/0	0/0	12/107,486	12/122,610	14/231,269
Community/ Noncomm[2]	0/0	0/0	0/0	0/0	6/28,976	7/2,197
Private[3]	NE	NE	NE	NE	NE	NE
Totals	0/0	0/0	0/0	12/107,486	18/151,586	21/233,466

Key:
NE=Not Evaluated
AOC=Aquifer of Concern
Footnotes:

[1] City of Jacksonville. This system is divided into two separate well systems referred to as the North and South Grids. All the municipal wells are open to the Floridan aquifer system. The North Grid well system consists of nine wellfields (47 wells). Three of the wellfields are located within 4 miles of the site. These wellfields include: the Main Street (10 wells), Fairfax Ave. (8 wells) and Norwood Ave. (4 wells) water treatment plant (WTP) wellfields. The nearest of these wellfields is the Main Street wellfield located between 1.3 and 1.7 miles south-southwest of the site. The North Grid system currently serves 420,989 people. The South Grid consists of six wellfields (24 wells). Four of the wellfields are located within 4 miles of the site. These wellfields include: the Arlington (4 wells), Hendricks Ave. (3 wells), Hendricks Ave. Expansion (2 wells) and River Oaks Road (7 wells) water treatment plant (WTP) wellfields. The nearest of these wellfields are the Arlington and Hendricks Avenue Expansion wellfields located between 2.8 and 3.4 miles east-southeast and south, respectively of the site. The South Grid system currently serves 396,461 people. No one well provides more than 40 % of the system's needs. Apportionment (North Grid) =420,989 people/47 wells = 8,957.2 people per well. Apportionment (South Grid) = 396,461 people/24 wells = 16,519.2 people per well [1,3,10,21,22,23].

[2] The larger size public well systems are open to the Floridan aquifer system. The community and noncommunity well data, including aquifer use, was provided by FDEP's PWS Potable well search database [21]. These locations, in addition to the municipal well locations, were subsequently plotted on the 4-Mile USGS topographic Tiger database map collage of the site [1].

[3] The average persons per household in Duval County (1990 U.S. Census) is 2.54 [1,29].

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Aka: Berman Brothers
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4

JOURNAL ARTICLE

Discovering unrecognized lead-smelting sites by historical methods

WP Eckel, MB Rabinowitz and GD Foster
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OBJECTIVES: Our objective was to enumerate unrecognized former lead smelters in the United States. METHODS: Defunct smelters were identified by historical research. The compiled list was compared with government registries of hazardous sites. Soil samples were taken from 10 sites. RESULTS: Approximately 430 sites were unknown to the federal authorities. Only 5 of 319 sites were known to authorities in the top 8 states. Nine of the 10 sites sampled exceeded residential standards for soil lead level. CONCLUSIONS: Approximately 430 former lead-smelting sites were unrecognized in the United States. Sampling results indicate that the sites may pose a threat to public health.

Reference 3

Supplementary Material

Appendix A: Battery Lead Smelters

Appendix B: Babbitt Metal and Solders Smelters

Appendix A
"Battery Lead Smelter" Sites Apparently Unknown to Federal And State Authorities

Site	Address	City	MSR
(State: Massachusetts, Region I)			
Harcon Corp.	41 Hilton St.	Boston	
Harcon Corp.	41 Bradston St.	Boston	
Vulcan Smelting Works	289 Third	Chelsea	
Richards Corp.	356 Commercial	Malden	
David Feinburg Co.	Fifth St.	Medford	plant
Arcade Smelting & Refining Corp.	--	Squantum	
(State: New Jersey, Region II)			
U.S. Metals Refining Co.	--	Carteret	equip
Magnolia Metal Co.	120 Bayway	Elizabeth	equip
Balbach Smelting & Refining Co.	Wilson & Doremus	Newark	plant
Barth Smelting Corp.	9 Fredon St.	Newark	
Eagle-Picher Lead Co.	--	Newark	
Hudson Smelting & Refining Co.	85-87 Hyatt Ave.	Newark	plant
Hudson Smelting & Refining Co.	576 Wilson Ave.	Newark	equip
Metal Reduction Corp.	4001 Dell Ave.	North Bergen	
Metals Disintegrating Co.	Morris Ave.	Townley	plant
(State: New York, Region II)			
City Metal Smelting & Refining Co.	61 N. 13th St.	Brooklyn	
Columbia Smelting & Refining Works	98 Lorraine	Brooklyn	
Consolidated Smelting	25 Provost Ave.	Brooklyn	
Fox & London Inc.	21 Provost St.	Brooklyn	
Glaser Lead Co.	21-31 Wyckoff Ave.	Brooklyn	
Kahn Bros. Smelting	785 Humboldt St.	Brooklyn	equip
Lee-Zurich Alloys Corp.	335 Calyer	Brooklyn	
United American Metals	970 Meeker St.	Brooklyn	
United American Metals	200 Diamond	Brooklyn	plant
Lake Erie Smelting Corp.	29 Superior	Buffalo	
Michael Hayman	856 E.Ferry	Buffalo	equip
National Lead	116 Oak	Buffalo	

Reliance Lead, Solder & Babbitt Co. Inc.	399 Gennessee St.	Buffalo	
Samuel Greenfield Co.	31 Stone	Buffalo	plant
Magnus Metals Div.	779 Walden Ave.	Depew	
Columbia Smelting & Refining Works Inc.	38-06 Review Ave.	Long Island City	
Goldsmith Bros. Smelting & Refining	43-20 12th St.	Long Island City	
Balbach Smelting & Refining Co.	63 Park Row	New York	
Duquesne Smelting Co.	18 E. 48th St.	New York	
Magnolia Metal Co.	75 West	New York	
Tottenville Copper Co.	Foot of W. 29th	New York	
A.M.A. Div.	P.O. Box 63	Oceanside	
A.M.A. Corp.	--	Rockville Centre	
Nassau Smelting & Refining Co.	603 W. 29th	Tottenville	plant

(State: Maryland, Region III)

Industrial Metal Melting	108 E. Barney	Baltimore	
Southern Smelting & Refining Works	200 Key Highway	Baltimore	plant

(State: Pennsylvania, Region III)

Hammond Lead Products	40 E. Main	Carnegie	
Schuylkill Valley Metals	--	Conshohocken	
Price Battery Corp.	--	Hamburg	
Penn Reduction & Refining Co.	--	New Castle	
American Alloys Co.	1939 E. Sargeant	Philadelphia	
Bers & Co.	Ashland & Lewis	Philadelphia	equip
Electric Storage Battery	42 S. 15th St.	Philadelphia	
Electric Storage Battery	19th & Allegheny	Philadelphia	
Girard Smelting & Refining Co.	Milnor & Bleigh Tacony Station	Philadelphia	plant
Halpern Metals Co.	5010 Lancaster Ave.	Philadelphia	
John T. Lewis & Bros.	2607 E. Cumberland	Philadelphia	
Jos. Rosenthal's Sons	1837 N. 2nd	Philadelphia	
Jos. Rosenthal's Sons	190-2 W. Berks St.	Philadelphia	
L. Goldstein's Sons Inc.	Wissinoming Ave. & Knorr	Philadelphia	equip
Ladenson Metals Co.	Castor Ave. E. of Richmond	Philadelphia	
Metro Smelting Co.	Ontario & Bath Sts	Philadelphia	
Morgan Smelters Inc.	Hedley St. E. of Richmond	Philadelphia	
Noth American Smelting	Tioga & Edgemont	Philadelphia	

Reference 4

Lead-Filled Lots

Study Says Potentially Toxic Sites Unlisted

By Rose Palazzolo
ABCNEWS.com

April 3 — Hundreds of former lead smelting factory sites, some next to residential neighborhoods, could contain toxic levels of lead and no regulatory agency is aware of them, according to a new survey.

The study, released in the *American Public Health Journal*, cites 430 former lead smelting factories that are apparently not listed by the Environmental Protection Agency or local Health Departments.

"It's a potentially dangerous finding," said William Eckel, who conducted the study as part of his doctoral thesis at George Mason University in Fairfax, Va. He did the investigation in collaboration with his advisor, Gregory Foster and Michael Rabinowitz, a geochemist with the Marine Biological Laboratory in Woods Hole, Mass.

Potentially Hazardous Lead Levels in Soil

In the study, Eckel lists the sites of 640 former lead smelting factories in 35 states, which he says are filled with potentially hazardous levels of lead in the soil. Most of the sites are concentrated in industrial centers including Brooklyn, N.Y., Detroit, Baltimore, Los Angeles and Chicago. Eckel said he found the sites by looking in old industry directories and cross checked his findings with federal and state databases. He spent six years combing through the databases and books.

Lead smelting factories reclaim the lead in items such as car batteries and convert it back to pure lead and lead alloys. To counter the leeching of contaminants sites are either paved over or cleaned up by EPA officials. But Eckel claims that at least 430 or two-thirds of former lead smelting sites he identified were not known by the EPA or by State Departments of Health and therefore weren't paved over or cleaned up.

Although Eckel currently works at the Environmental Protection Agency, the EPA had nothing to do with his study and would not comment on the findings.

"It's impossible for us to comment on a study that we haven't even seen," said EPA spokesman Chris Paulitz. "Also, it is hard for us, as a new agency, to comment on what a previous agency [under former President Clinton] may or may not have done in terms of listing potential hazardous sites."

Potential For Great Lead Damage

Eckel, who now works at the pesticides division of the EPA, said that his study should send out an alarm. "If these sights are still contaminated and haven't been paved over there is potential for great lead damage here," he said.

While touring several sites in Pennsylvania and Baltimore Eckel noted that more than a few were just across from homes. One site was actually underneath an elevated section of a freeway next to the Orioles Stadium in Baltimore. When he tested these sites their lead levels exceeded those allowed by federal law for industrial sites and seven of the sites had levels exceeding the residential maximum.

"Not all the sites are necessarily contaminated, but they should all be checked out," Eckel said.

Large amounts of lead in a child's blood can cause brain damage, mental retardation, behavior problems, anemia, liver and kidney damage, hearing loss, hyperactivity, developmental delays and in extreme cases, death. There is new evidence that lead poisoning is harmful at blood levels once thought safe. Lower IQ scores, slower development and more attention problems have been observed in children with very low lead levels.

"Lead affects nearly every system of the body," says Barbara Materna, chief of the Occupational Lead Poisoning Prevention Program of the California Department of Health Services. Because it can cause so much damage, lead is the only environmental toxin for which children are routinely screened. Lead in the bloodstream can also lead to nerve damage and kidney failure and, in adults, infertility, miscarriages, and an inability to produce red blood cells.

The sites that Eckel found have as high as 10 percent lead by weight in soil. The EPA standard is 0.04 percent in residential areas and 0.1 percent in industrial areas. Some of the sites are in Boston, Buffalo, Chicago, Dallas, Detroit, Houston, Jersey City, Los Angeles, Newark, New York, Philadelphia, Pittsburgh, and San Francisco. ■

Reference 5

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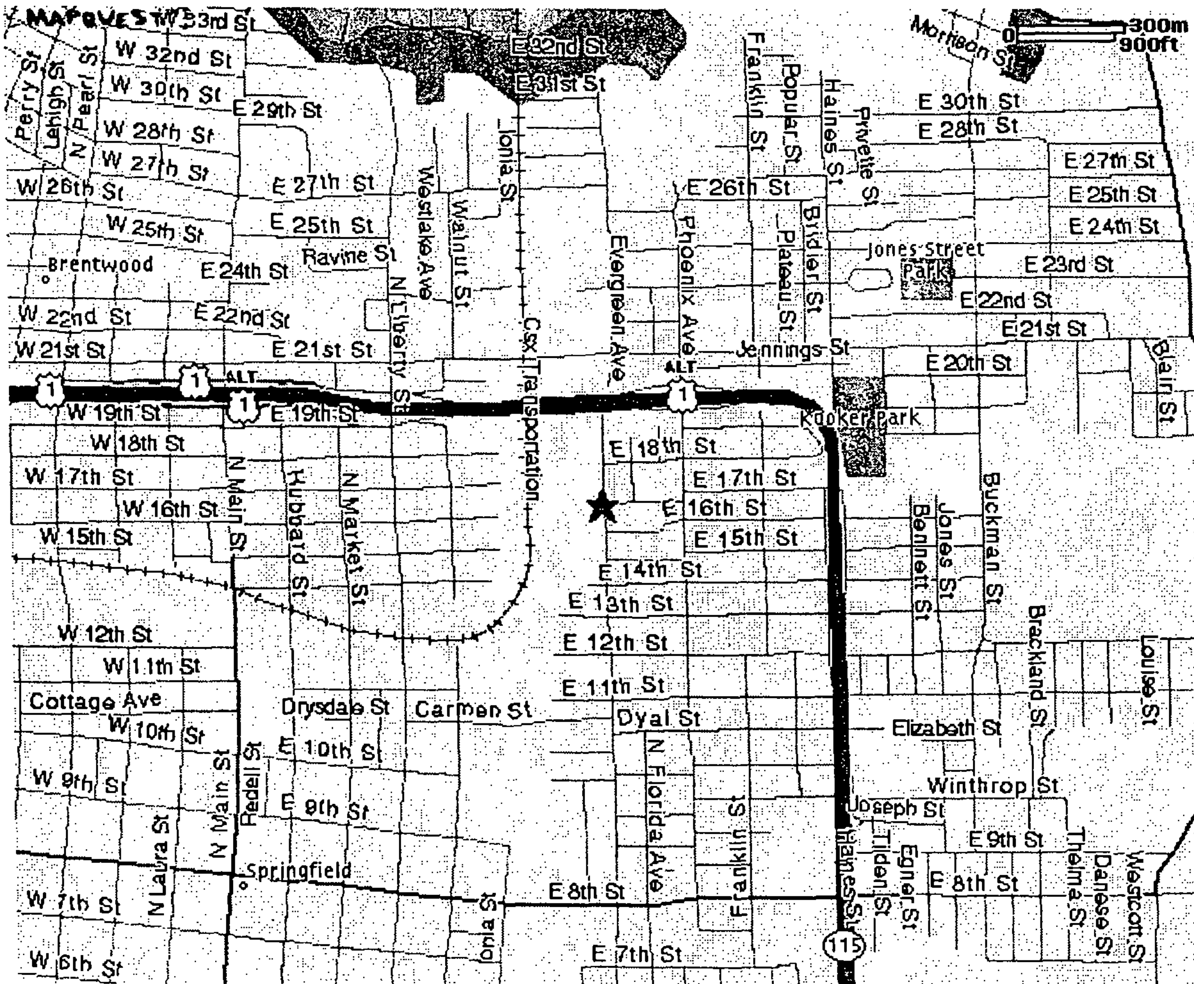

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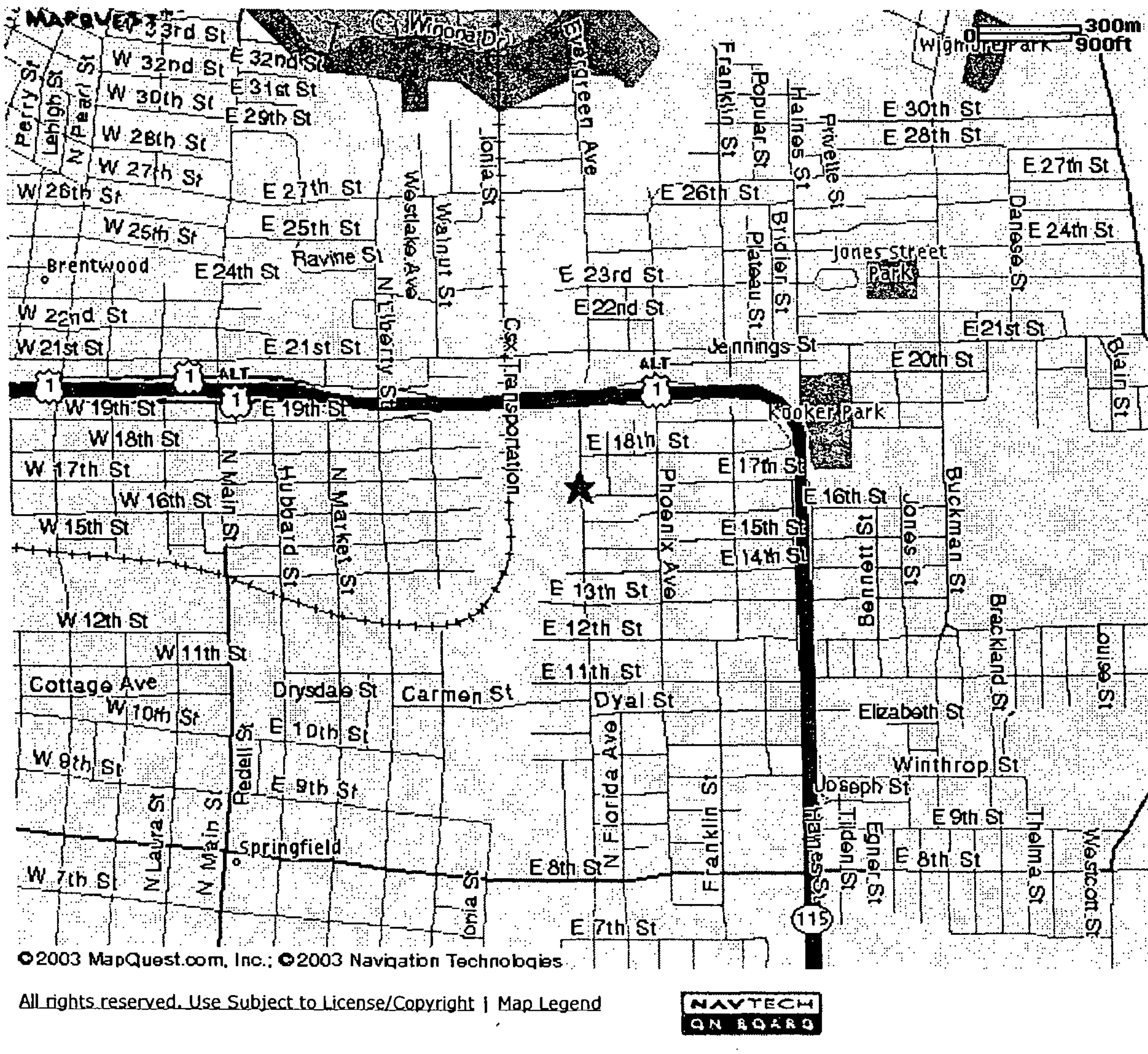

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PRELIMINARY CONTAMINATION ASSESSMENT REPORT

FOR

BERMAN BROS., INC. SITE
JACKSONVILLE, FLORIDA

DOCKET #__________

PREPARED BY:

PITMAN • HARTENSTEIN & ASSOC., INC.
ENGINEERS

PRELIMINARY CONTAMINATION ASSESSMENT REPORT

FOR

BERMAN BROS., INC. SITE
JACKSONVILLE, FLORIDA

SUBMITTED TO: FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
Northeast District
7825 Baymeadows Way
Suite B 200
Jacksonville, Florida 32256-7577

JANUARY 1992

SUBMITTED BY:

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Paul L. Tinkham, Project Manager

Robert W. Bass, P.G. Geologist

Paul L. Tinkham 2/3/92
Signature Date

Robert W. Bass 2/3/92
Signature Date

SEAL

DOCKET # ________

TABLE OF CONTENTS

I. INTRODUCTION

1. Purpose of Report

The purpose of this report is to provide a summary of the results and conclusions of the Preliminary Contamination Assessment Plan (PCAP) implemented in response to the orders issued in the OGC Consent Order No. 91-0681 filed on July 26, 1991 in FDER office Jacksonville, Florida.
This PCAP was approved by letter on October 18, 1991 by Dr. Brian Cheary of the Bureau of Waste Cleanup. (Appendix A)

The firm of Pitman-Hartenstein & Assoc., Inc. (PH&A) has been selected to coordinate, manage and supervise this project to assure the work is done per FDER requirements and standards, in a quality manner and to generate a quality PCAP/PCAR document for submittal. Assisting PH&A will be Integrated Environmental Solutions, Inc. (IES) to perform all subsurface well installations, soil and groundwater sampling and data interpretation per IES' FDER approved Comprehensive Quality Assurance Plan (CQAP) No. 890280G. Performing the analysis on the soil and groundwater samples will be Southeastern Environmental Laboratories, Inc. per their CQAP No. 880633G.

2. Site Description

The project study area is located in Jacksonville, Duval County, Florida, Section 6, Township 2 South, Range 27 East (Figure 1). It consists of approximately 5.5 acres of land area most of which is owned by Berman Bros., Inc. with a small portion leased from the Jacksonville Port Authority (Figure 2). The site is bounded on the north by the 20th Street Expressway, on the west by Seaboard Coast Line Railroad, on the south by 16th and 17th Streets and on the east by Preston Street and Florida Avenue.

The property in the vicinity of the site consists of low-income single-family residential housing, commercial establishments, railroad switching facilities and industrial uses. Property zoning consists of Industrial; Light and Warehouse District (ILW), and Industrial; Heavy District (IH). The Flood Hazard Zone Classification for the property is Zone C; area outside the 100 year flood zone. There is no surface water located within the leased Jacksonville Port Authority property boundary under this project study.

The major percentage of stormwater runoff flows generally from the northwestern portion towards the southeastern portion of the site.

Water is provided to the site from the City of Jacksonville via an 8-inch water line on the west side of Evergreen Avenue. Sewer service is also provided by the City via an 8-inch gravity line. Electricity is provided by Jacksonville Electric Authority and natural gas is provided by People's Gas via a gas line running along Evergreen Avenue.

3. Site History

This site has operated as a scrap metal processing facility for almost sixty years with initial operations beginning in the 1930's. Prior to World War II, the Wolfson family conducted scrap metal collection and managed the site as a depot. Later, around 1965, the present owners; Berman Bros., purchased the facility and have continued to operate it as a scrap metal processing site. Several property acquisitions over the years have expanded the site both eastward and southward to its present boundaries.

Current operations at this facility include non-ferrous scrap processing of copper, brass, aluminum and stainless steel, ferrous scrap processing, and new steel and pipe warehousing for structural steel and piping supplies.

II. REGIONAL GEOLOGY & HYDROGEOLOGY

1. Regional Geology

The uppermost geologic formations in the vicinity of the site are deposits of Pleistocene and Recent age. These sediments were deposited during the formation of marine terraces and beach ridges and blanket all of Duval County. The deposits consist primarily of tan to yellow medium- to fine-grained loose quartz sand, locally stained rusty brown and red from iron oxide. They also contain thin gray sandy clay beds, which, in places, contain mollusk shells. Discontinuous layers of rusty brown hardpan, composed of slightly to well-indurated iron-oxide cemented quartz underlie some of the higher areas.

The uppermost geologic formations are underlain by deposits of Miocene or Pliocene age. The upper portion of these deposits consist of sand, shell, sandy clay and limestone. The majority of these deposits are the Hawthorn Formation. The Hawthorn Formation consists mainly of dark-gray and olive-green sandy to silty clay, clayey sand, clay, and sandy limestone, all containing moderate to large amounts of black phosphate sand, granules, and pebbles. In most places the upper surface of the Hawthorn is marked by the presence of phosphate-rich sediments.

The above described sediments are underlain by several thousand feet of limestones of Eocene age. In descending order, underneath the Hawthorn Formation, is found the Ocala Group, The Avon Park Limestone, and the Lake City Limestone.

Table 1 lists the formations with depth and lithology down through the Lake City Limestone. The formations older than the Lake City are not included because they are not generally penetrated by wells in the area. Figure 3 is a regional geologic cross section through the study area.

2. Regional Aquifers and Confining Units

The ground water in the vicinity of the site occurs under both artesian and nonartesian conditions. The site is underlain by three Class G-ii aquifer units. The uppermost aquifer unit is a nonartesian aquifer than includes Pleistocene deposits and Miocene or Pliocene deposits. Recharge occurs from direct infiltration of local rainfall. Discharge results from pumpage, outflow from

evapotranspiration and baseflow into surface water bodies. Water production from the nonartesian aquifer is minimal. The clayey sand and silty clay layers serve as confining units. The uppermost aquifer is not used for a ground water resource in the area.

The secondary aquifer is composed of sand, clay, limestone and dolomite lenses within the Hawthorn Formation. This aquifer usually occurs under artesian conditions in Duval County. The Hawthorn Formation acts as an aquiclude between the shallow surficial and the Floridan aquifer. Water production from the secondary aquifer is slightly higher than the nonartesian aquifer. The secondary aquifer is no longer used for a ground water resource as the area is now served by a public water supply system.

The Floridan aquifer exists under artesian conditions and is the principal source of freshwater in northeast Florida. It includes the Lake City Formation, Avon Park Formation and Ocala Group. An extensive aquiclude in the overlying Hawthorn Formation separates the Floridan aquifer from the shallow aquifer system. Recharge occurs in Western Duval County approximately twenty (20) miles

III. SOIL AND GROUND WATER INVESTIGATION

1. Ground Water Flow Direction

Three temporary piezometers were installed at the site during the preparation of the PCAP at locations shown in Figure 5 to determine the ground water flow direction. The ground water flow direction was determined to be to the south and south southwest based on the water table elevations taken during the preparation of the PCAP. The temporary piezometer construction detail is shown on Figure 6.

Four shallow ground water monitoring wells were installed during the implementation of the approved PCAP at locations shown in Figure 5. The locations of the ground water monitoring wells were based on the ground water flow direction determined from the three temporary piezometers described above. The ground water monitoring well construction detail is shown on Figure 7.

The top of casing of each piezometer and ground water monitoring well was surveyed relative to a common datum. Depth to water was measured with an electrical tape and ground water elevations were calculated. A summary of the ground water measurements and elevations is in Table 2. All elevations and measurements are to within 0.01 feet.

The ground water elevations of the temporary piezometers and ground water monitoring wells were used to construct a Ground Water Flow Direction Map (Figure 4). As shown, the ground water flow direction across the study area is now toward the north and northwest.

2. Ground Water Monitoring Well Installations

In accordance with the approved PCAP, four ground water monitoring wells were installed at locations shown on Figure 5. Monitoring well MW-1 was to be located upgradient of the area of greatest concern and was considered to be an

unaffected background well. Monitoring well MW-2 is located in the area of greatest concern and in the approximate center of the study area. Monitoring wells MW-3 and MW-4 were to be located downgradient of the area of greatest concern.

The ground water monitoring wells were constructed using the auger method. No drilling fluids were used during well construction. All augers and drilling equipment was steam cleaned prior to installation of the first well and after the installation of each well to prevent cross contamination.

The wells consist of ten feet of 0.01-inch slotted Schedule 40 PVC placed such that the screened interval will extend across the water table to allow free floating product, if present, to enter the well. The screened intervals were installed such that they extend from twelve feet to two feet below land surface.

Solid Schedule 40 PVC casing extends from the top of the screened interval to approximately 2.5 feet above land surface. A sand filter pack consisting of 20-30 grade silica sand was placed in the annulus over the screened interval. Neat cement grout was placed in the annulus from the top of the screened interval to land surface.

Each well was finished with a 2' x 2' x 6" concrete base and a locking steel riser. The ground water monitoring well construction detail is shown on Figure 7. Each well was developed by pumping at a rate greater than well yield. The elevation of the top of casing of each ground water monitoring well was determined relative to the same common datum as the existing piezometers.

3. Soil Sampling

Soil samples were taken during the installation of the ground water monitoring wells. One composite soil sample was collected from the soils encountered from land surface to the top of the water table at each drilling location. Soil samples were obtained using a decontaminated stainless steel hand auger according to the referenced CompQAP.

4. Ground Water Sampling

The ground water sampling event was conducted approximately twenty-four hours after well installations. The depth to water was measured in each ground water monitoring well prior to purging. The depth to water in the existing piezometers were also be measured in order to develop a more detailed ground water flow direction map. Each ground water monitoring well was purged of at least five well volumes prior to sampling. Samples were obtained according to the referenced CompQAP.

Ground water samples were obtained using a decontaminated Teflon bailer. Conductivity, temperature and pH were measured in the field. One field equipment blank was taken after well sampling and analyzed for the same parameters as the well samples.

Approximately one month after the initial ground water sampling and after review of the initial data, the four ground water monitoring wells were purged of at least five additional well volumes and resampled for selected parameters.

5. Surface Water and Sediment Sampling

No surface water is located in the study area. Therefore, pursuant to the approved PCAP, no surface water or sediment sampling was conducted.

6. Laboratory Analyses

Pursuant to the approved PCAP, the soil samples were analyzed for PCBs and total metals for the eight RCRA metals. A summary of the soil analytical results are listed in Table 3. Only analytes present above their relative minimum detection limits are listed in the summary table. PCBs, barium, chromium and lead were detected at concentrations above their relative minimum detection limits. All other parameters analyzed are below their relative minimum detection limits. The complete soil analyses laboratory results are in Appendix C.

Ground water samples were analyzed for PCBs and total metals for the eight RCRA metals. A summary of the ground water analytical results are listed in Table 4. Only analytes present above their relative minimum detection limits are listed in the summary table. The complete initial round of ground water analytical results are in Appendix C.

A second round of ground water sampling and analyses was conducted for the parameters detected in the initial round of ground water analyses with the exception of barium. Barium was not analyzed during the second round of analyses because the level of barium detected in the initial round was significantly below the primary drinking water standard. All ground water monitoring wells were thoroughly purged of a minimum of five well volumes prior to sampling. Additionally, a filtered sample was taken for the second round of samples analyzed for lead in order to determine if the source of lead was related to turbidity.

Although PCBs and lead were detected in the initial round of ground water sampling, these parameters were found to be below their relative minimum detection limit during the second round of ground water sampling. The levels of PCBs and lead found in the initial sampling event are attributed to carry-down of PCBs from the soil above the water table during the well installation and from turbidity in the initial ground water sample; therefore, the results from the initial sampling event are not believed to be representative of ground water conditions at the site. A summary of the second round of ground water analytical results are listed in Table 4. The complete second round of ground water analytical results are in Appendix C.

7. Aquifer Hydraulic Conductivity and Flow Rate

The affected aquifer is a shallow surficial aquifer with a G-II classification. The water table was generally found at approximately five to six feet below land surface.

Slug tests were conducted on ground water monitoring wells MW-1, MW-2 and MW-3. The calculated hydraulic conductivities (K) are as follows:

Well No.	Hydraulic Conductivity (K)
MW-1	13.86 ft/day
MW-2	8.15 ft/day
MW-3	8.63 ft/day

The average hydraulic conductivity (K) calculated from the slug tests is 10.21 feet per day (ft/day). Slug test field data sheets and calculations are found in Appendix D.

The ground water flow direction determined during the implementation of the PCAP is to the north and northwest. Water table elevation measurements were taken on January 27, 1992. The ground water elevation data are listed in Table 2.

A ground water contour and flow direction map based on the ground water elevation data listed in Table 2 is presented in Figure 4. The ground water underlying the site is not tidally influenced.

The ground water flow velocity through the pore space (V_p) is calculated according to the following FDER recommended equation:

$$V_p = \frac{K \times I}{n} = .163 \text{ ft/day} \quad (59.6 \text{ ft/year})$$

Where:

K = hydraulic conductivity (from slug tests) = 10.21 ft/day
I = hydraulic gradient (calculated from Figure 7) = 0.004 ft/ft
n = effective porosity (Groundwater & Wells, pg. 67) = 25%

The net linear (horizontal) flow velocity (V_n) is calculated using Darcy's Equation and the same K and I as above as follows:

$$V_n = K \times I = 0.041 \text{ ft/day} \quad (14.9 \text{ ft/year})$$

The transmissivity (T) of an unconfined aquifer is calculated as the product of hydraulic conductivity (K) and the effective aquifer thickness (b), defined as the total screened interval below the water table in the wells as follows:

$$T = Kb = 0.041 \text{ ft/day} \times 8 \text{ ft} = .328 \text{ ft}^2\text{/day}$$

IV. Local Well and Surface Water Survey

Pursuant to Section IV of the approved PCAP, a survey of potable water wells and surface water bodies was conducted within a half-mile radius of the subject site. This survey included number and location of all public and private potable supply wells and any significant surface water bodies.

1. Potable Supply Wells

Information on potable supply wells within a half-mile radius of the subject site was obtained by reviewing files at the office of the St. Johns River Water Management District and Bio-Environmental Services Department.

A request for information for potable supply wells was made of the agencies on January 9, 1992. They provided a listing of seven (7) well locations within the half-mile radius of interest. Testing was not performed on the water from these wells to verify if they are, in fact, potable or are only registered as such.

Site visits were made to these sites to verify the well location and gather additional field data on the site. Locations may be found shown on Potable Supply Well and Surface Water Map on Figure 8.

The following list of well locations and owners was developed during this survey:

1. J98 30°21'16"N 81°39'08"

   Owner: King Edward Cigar Co.
   120 E. 18th Street
   353-4311

   City Record: 10" Unused

   Current Status: Unknown, residential dwelling on property, occupants not home. Well was not visible on the property, unable to physically locate or determine use.

2. J251 30°20'40"N 81°38'36"

   Owner: Atlantic Ice Company
   626 E. 8th Street

   City Record: Industrial

   Current Status: Unknown, building vacant. Well not visible on the property, unable to physically locate or determine use.

3. J249(D185) 30°20'48"N 81°38'50"

Owner: Duval Laundry
1905 Walnut Street

City Record: 4" Unused

Current Status: Active, domestic

4. J276 30°21'12"N 81°38'47"

Owner: John H. Swisher & Co.
459 E. 16th Street
353-4311

City Record: 4" Domestic

Current Status: Active, domestic

5. J2862 30°21'12"N 81°38'47"

Owner: John H. Swisher & Co.
459 E. 16th Street
353-4311

City Record: Industrial

Current Status: Inactive

6. J1383 30°21'01"N 81°38'38"

Owner:

City Record: Irrigation

Current Status: Inactive

7. J284(D217) 30°21'00"N 81°38'56"

Owner: Southern Railroad
Norfolk Southern Railroad
366-1499

City Record: Industrial

Current Status: Unknown, inside locked vacant building at 2101 N. Liberty Street.

2. Surface Water

A U.S. Geological Survey Map; Jacksonville Quadrangle, 1970 Revision was used in conjunction with the Soil Conservation Service Soil Survey Map of the City of Jacksonville to locate surface water bodies within a half-mile radius of the subject site.

The only surface water determined to be in the area was a large stormwater drainage ditch running along the northern side of 17th Street, beginning at Phoenix Street and running east to the Buckman Street Wastewater Treatment Facility. Upon physical inspection of this drainage ditch on December 3, 1991, the ditch contained approximately 4-8" of water moving relatively slowly toward the east. This drainage ditch is shown on the Potable Supply Well and Surface Water Location Map on Figure 8.

V. Conclusions

Groundwater was found to be free of PCBs and the eight (8) RCRA metals within the study area.

Soil in the study area has low levels of PCBs found in the range of BDL to 10 ppm.

Oil was found floating on the surface of the groundwater in MW-2 at a thickness in excess of two (2) feet with 101 ppm PCB content.

The eight (8) RCRA metals were analyzed on soil samples from the study area with barium, chromium and lead detected.

Groundwater flow direction was determined to be South Southwest during preparation of the PCAP. Upon implementation of the PCAP, it was noted the groundwater table had fallen approximately two (2) feet and groundwater flow direction changed to North to Northwest across the study area.

TABLE 1 - REGIONAL GEOLOGY

DEPTH BELOW LAND SURFACE	FORMATION	REMARKS
0 - 80 ft.	Pleistocene Sediments	Sand & sandy clay, unconsolidated
80 - 160 ft.	Miocene or Pliocene Sediments	Sand, clay & sandy clay, unconsolidated
160 - 210 ft.	Hawthorn Formation	Sandy clay & marl with sand & limestone lenses, unconsolidated
210 - 380 ft.	Ocala Group	Marine limestone
380 - 610 ft.	Avon Park	Dolomitic limestone
610 - 1060 ft.	Lake City	Fossiliferous limestone, massive limestone and crystalline dolomite

TABLE 2 - GROUND WATER ELEVATION DATA
(JANUARY 27, 1992)

WELL NUMBER	TOP CASING ELEV. (FEET ASL)	DEPTH TO WATER (FT BMP)	WATER LEVEL ELEV. (FT ASL)
MW-1	9.53	6.05	3.48
MW-2	9.79	Free Product >2 FT	
MW-3	11.02	7.12	3.90
MW-4	10.37	6.74	3.63
P-1	10.40	6.78	3.62
P-2	10.42	6.91	3.51
P-3	10.03	6.57	3.46

ASL = Above Mean Sea Level
BMP = Below Measuring Point

TABLE 3 - SOIL ANALYTICAL RESULTS SUMMARY

PARAMETER	Unit	MW-1	MW-2	MW-3	MW-4	Standard
PCBs	MG/KG	<0.1	5.0	0.4	3.0	N/A(1)
Barium	MG/KG	1.08	5.10	5.14	1.78	None
Chromium	MG/KG	<1.0	<1.0	1.16	<1.0	None
Lead	MG/KG	<1.0	7.60	40.8	2.90	None

MG/KG = Milligrams per kilogram or parts per million (ppm).

Note: Metals analyses are total metals.
All concentrations in milligrams per kilogram (ppm).

(1) N/A = Not Available. The State of Florida does not have a standard for PCBs in soil. PCBs are regulated at the federal level through the EPA. A request has been made to Region IV for a reference relative to an action level of PCBs in soil. A response to that request has not been received as of the date of this report submittal.

TABLE 4 - GROUND WATER ANALYTICAL RESULTS SUMMARY

PARAMETER	Unit	MW-1	MW-2	MW-3	MW-4	Standard
Initial Sampling Event:						
PCBs	UG/L	<0.7	5.0	<0.7	10.0	PQL(1)
Barium	MG/L	0.096	0.446	0.204	0.095	1.00(2)
Lead	MG/L	0.483	0.065	0.525	0.044	0.05(2)
Second Sampling Event:						
PCBs	UG/L	NA	<0.65	NA	<0.65	PQL(1)
Lead(3)	MG/L	<0.025	<0.025	<0.025	NA	0.05(2)

UG/L = Micrograms per liter or parts per billion (ppb).

MG/L = Milligrams per liter or parts per million (ppm).

NA = Not analyzed.

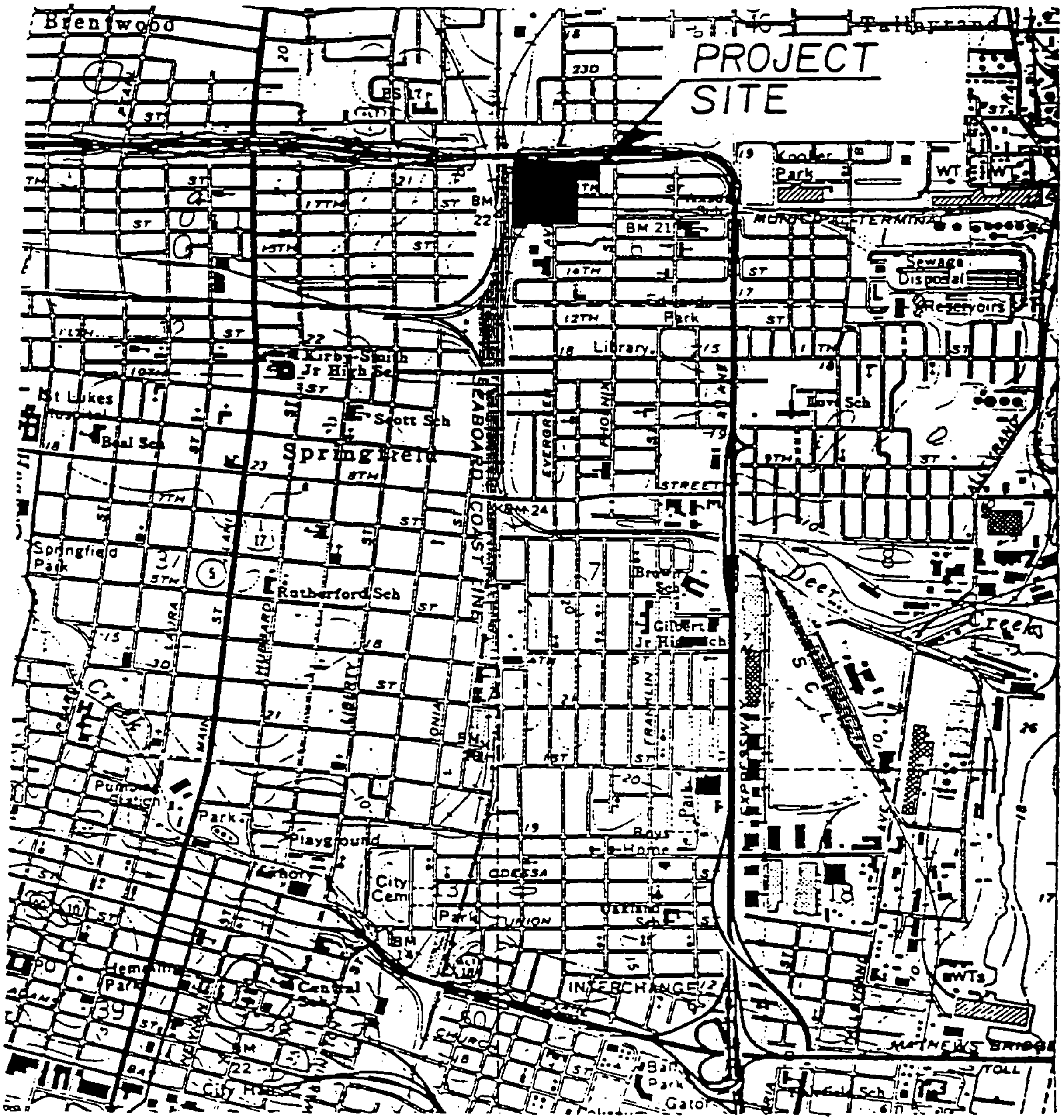
Notes:

(1) PQL = Practical Quantitation Limit as listed in the document *Ground Water Guidance Concentrations*, Florida Department of Environmental Regulation, Division of Water Facilities, Bureau of Ground Water Protection, February 1989.

(2) Primary drinking water standard.

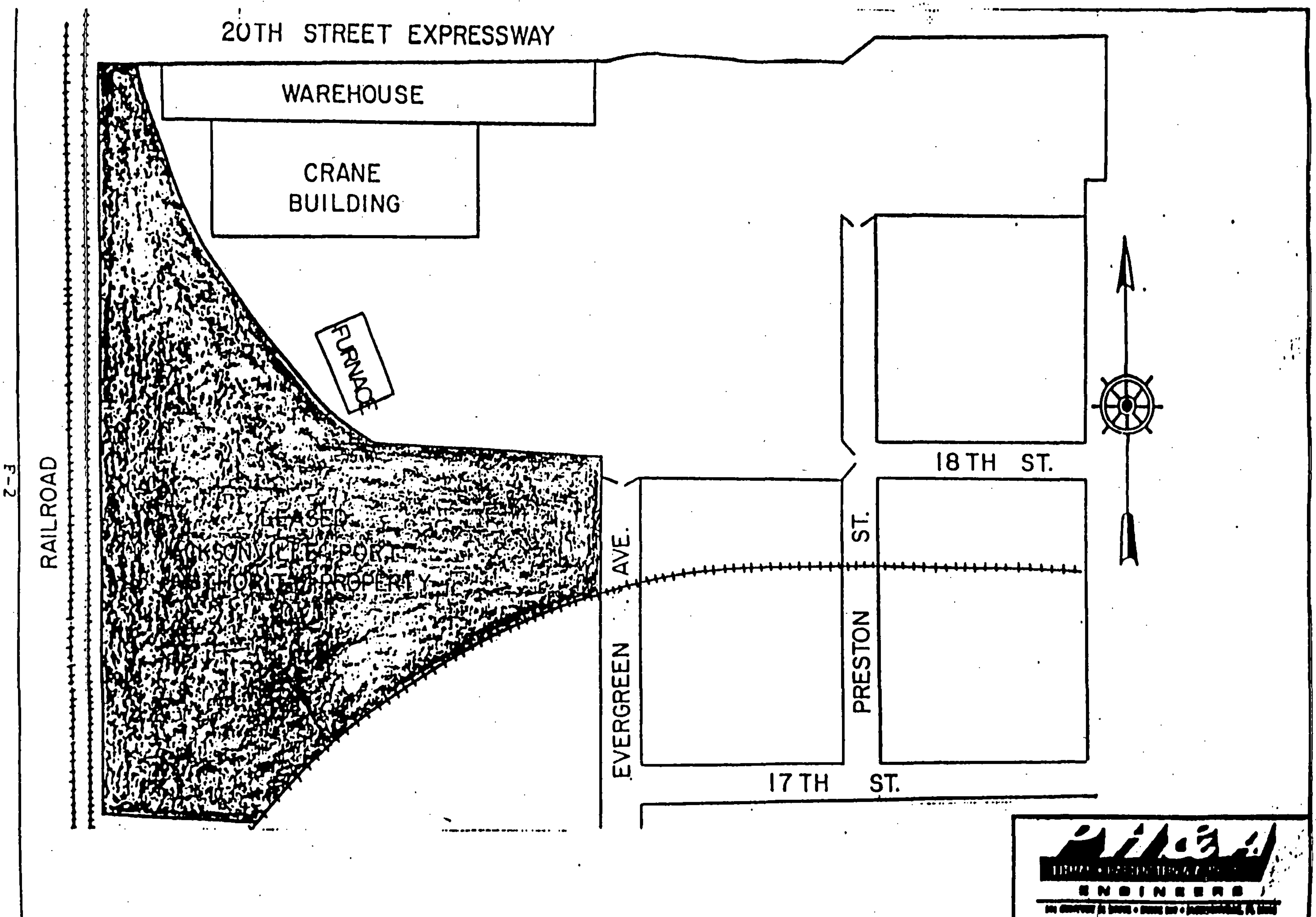
(3) Unfiltered fraction.

VII FIGURES



PROJECT	
PCAP / PCAR	PITMAN • HARTENSTEIN & ASSE. INC ENGINEERS

TITLE	PROJECT NO. BER 9136-5	DATE 08-27-91
SITE LOCATION MAP	SCALE	
	PAGE NO.	FIGURE NO. 1

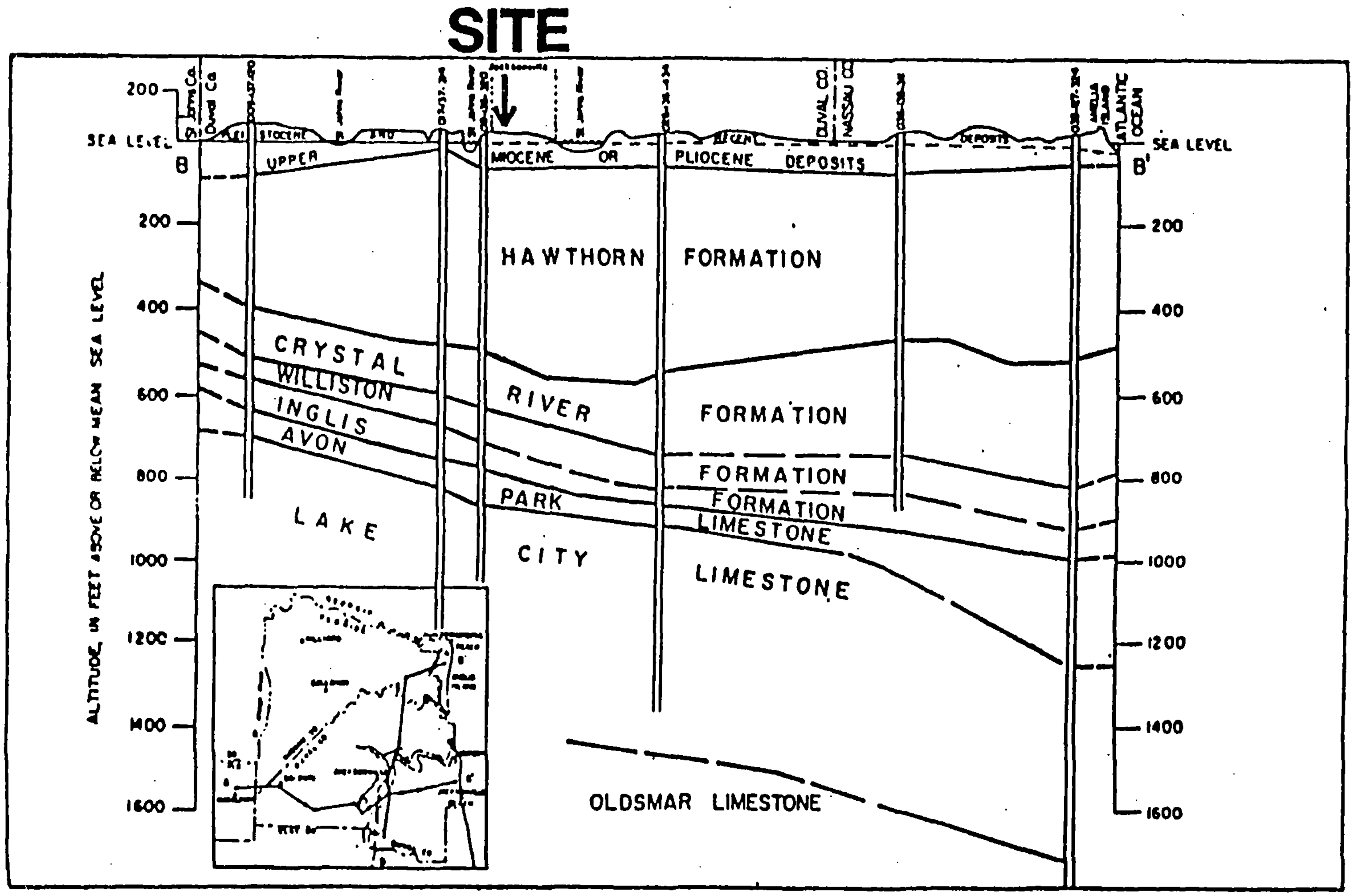


PROJECT NO. BER 9158-5

DATE 08-27-91

SCALE

SITE SKETCH



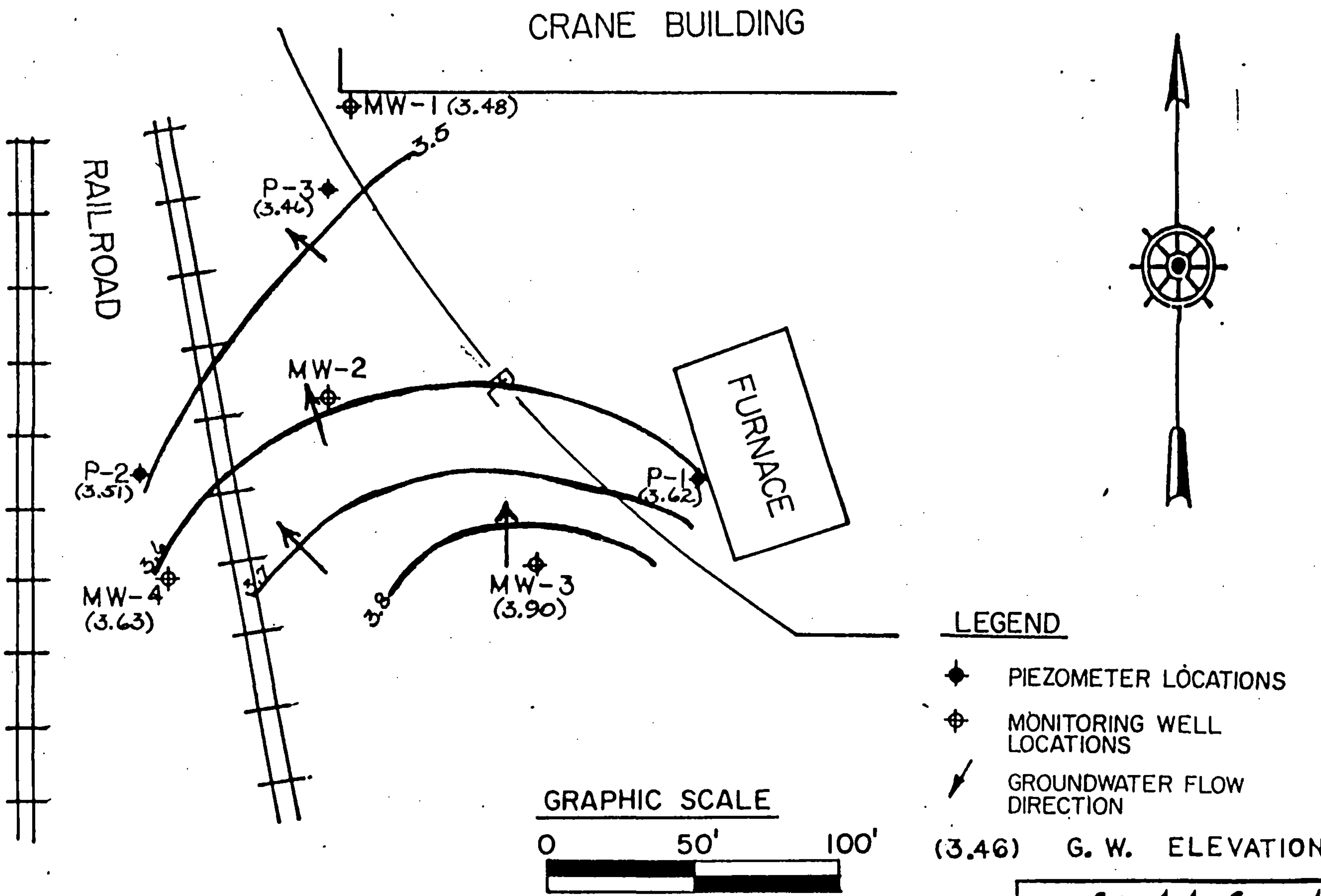
0 5 10miles
scale

SOURCE: FLORIDA GEOLOGICAL SURVEY RI NO. 43

PITMAN • HARTENSTEIN & ASHE INC
ENGINEERS

PROJECT NO.	DATE
BER 9136-5	08-27-91
SCALE	
PAGE NO.	FIGURE NO.

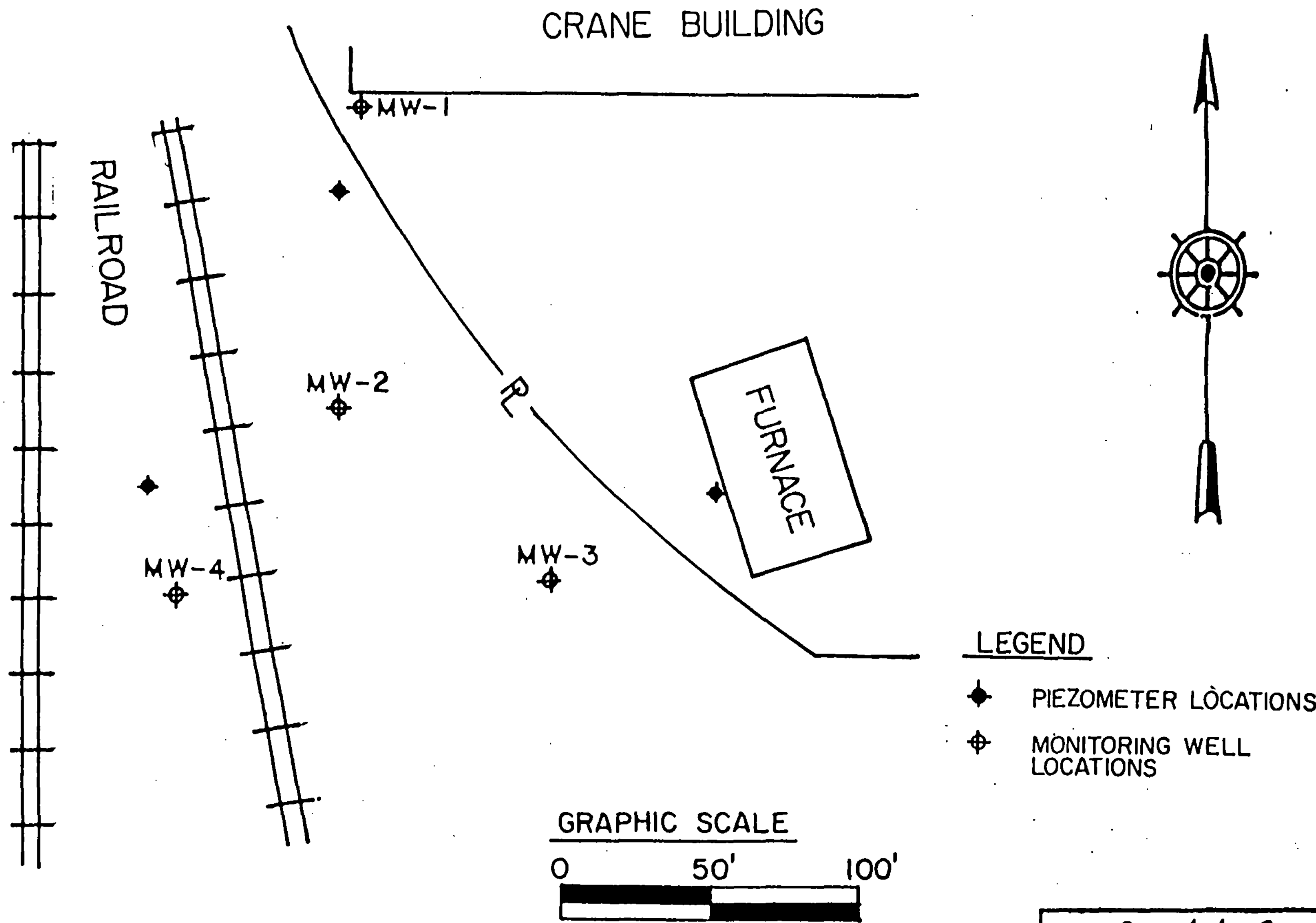
REGIONAL GEOLOGIC CROSS SECTION



PITMAN • HARTENSTEIN & ASHE INC
ENGINEERS

PROJECT NO.	DATE
BER 9136-5	01-24-92
SCALE 1" = 50'	
PAGE NO.	FIGURE NO. 4

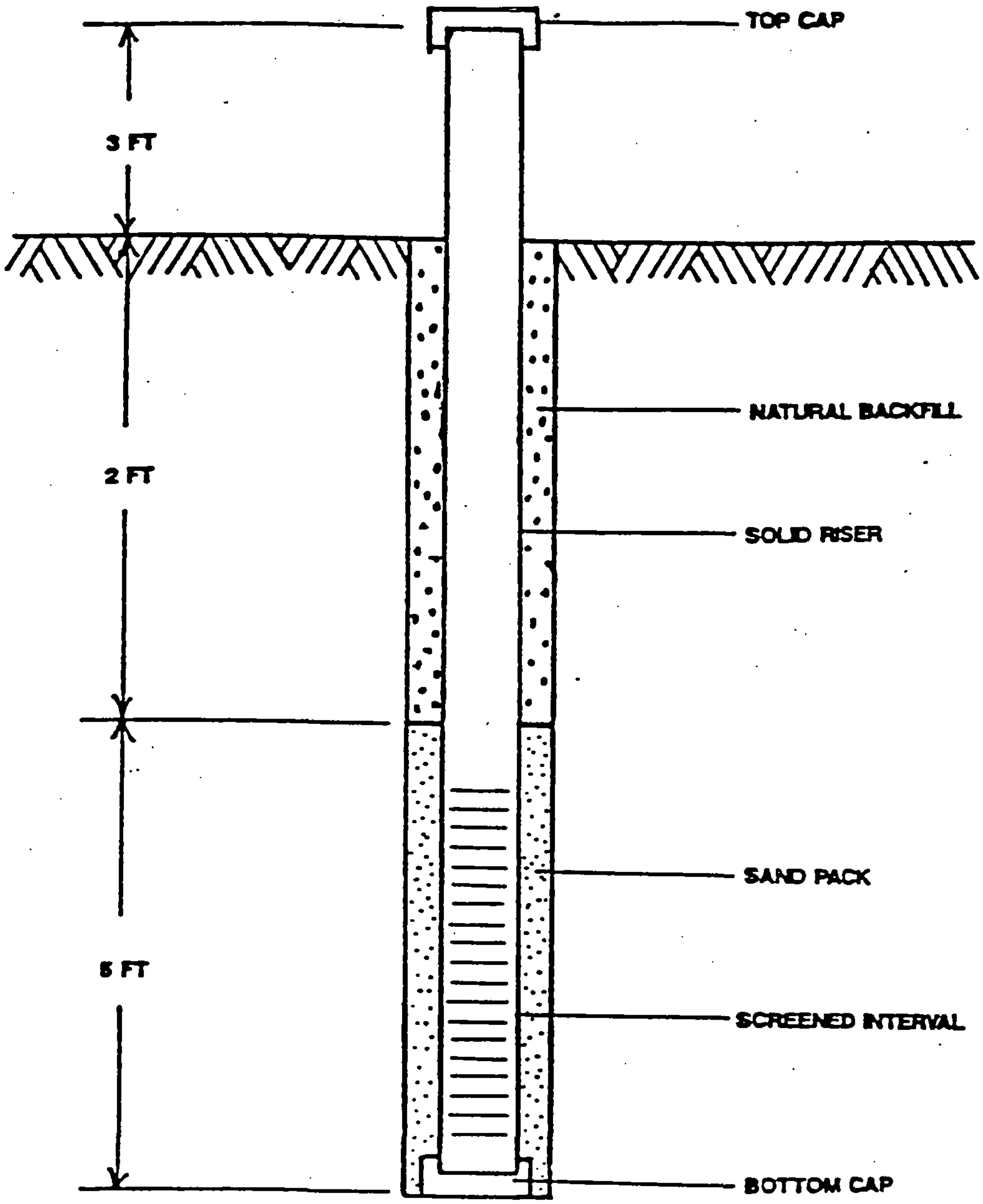
GROUND WATER FLOW DIRECTION MAP



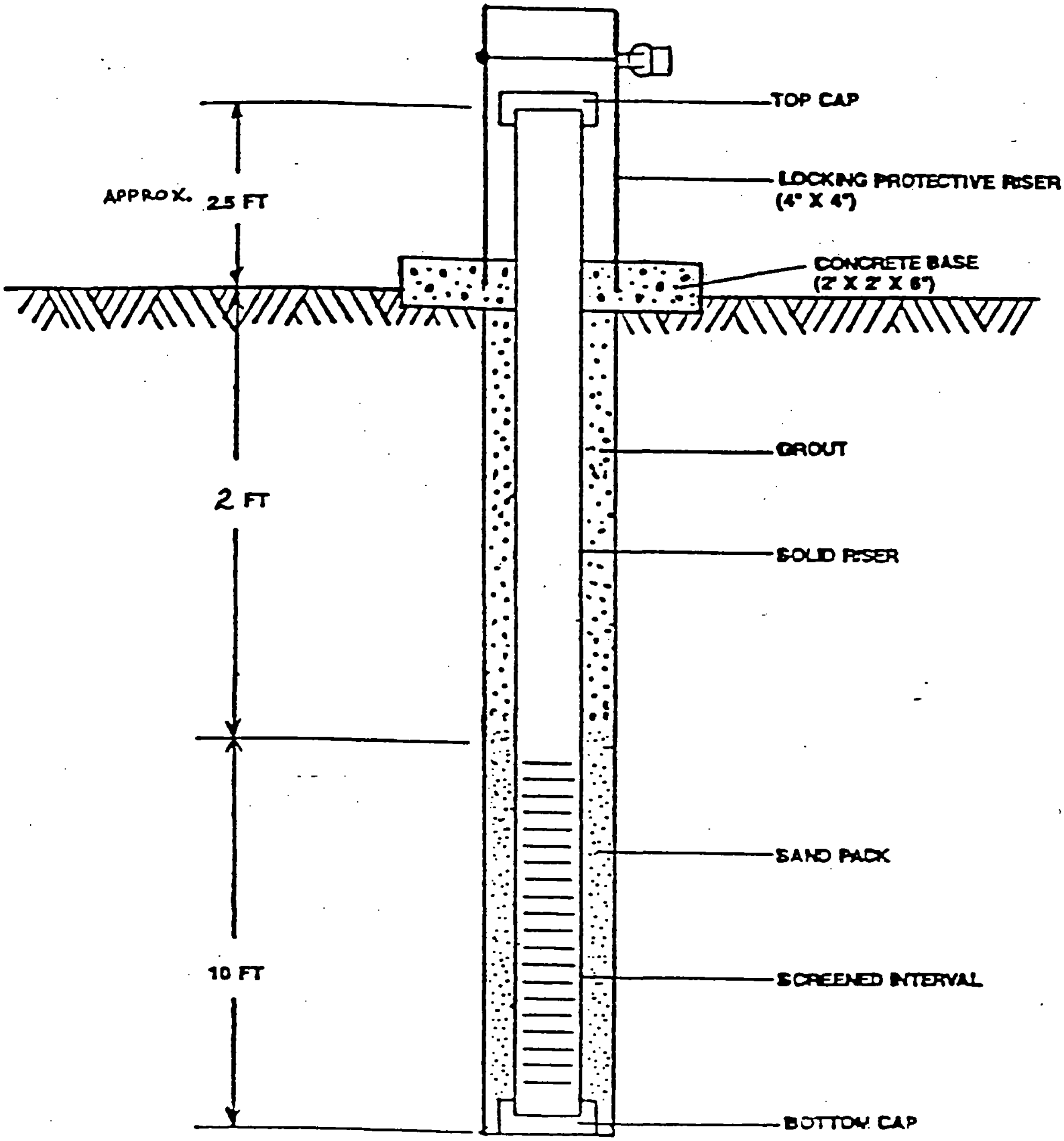
GROUNDWATER MONITORING WELL AND SOIL SAMPLING LOCATION MAP

ENGINEERS

PROJECT NO. BER 9136-5	DATE 01-24-92
SCALE 1" = 50'	
PAGE NO.	FIGURE NO. 5



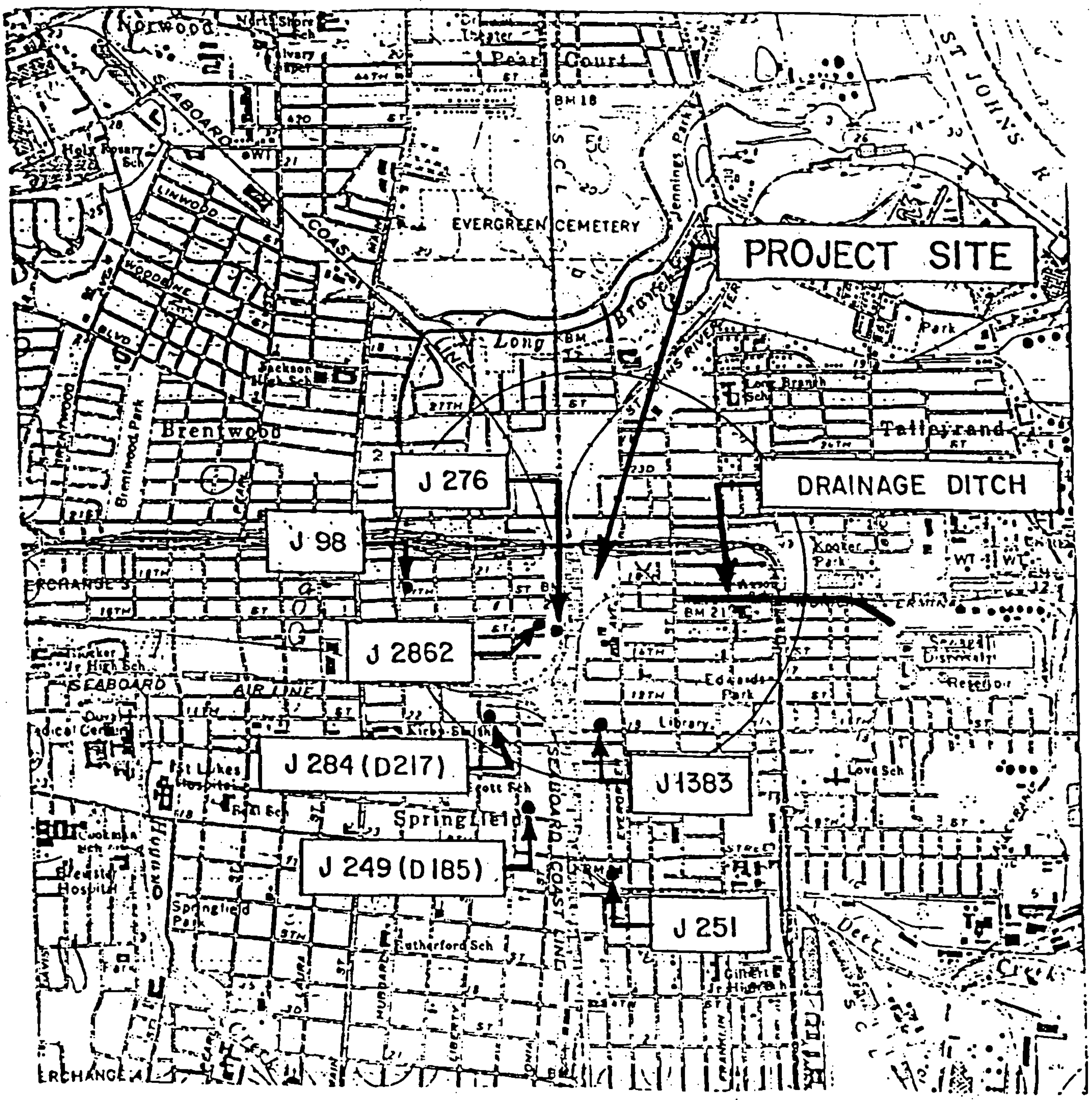
ROJECT	PITMAN • HARTENSTEIN & ASSOC. INC ENGINEERS
TITLE PIEZOMETER CONSTRUCTION DETAIL	PROJECT NO. BER 9136-5 / DATE 08-27-91 / SCALE / PAGE NO. / FIGURE NO. 6



NOT TO SCALE

PROJECT	
PCAP/PCAR	PITMAN • HARTENSTEIN & ASHE, INC. ENGINEERS

TITLE	PROJECT NO.	DATE
GROUND WATER MONITORING WELL CONSTRUCTION DETAIL	BER 9136-5	01-24-92
	SCALE	
	PAGE NO.	FIGURE NO. 7



PROJECT	
PCAP/ PCAR	PITMAN • HARTENSTEIN & ASHE, INC ENGINEERS
TITLE: POTABLE SUPPLY WELL AND SURFACE WATER LOCATION MAP	PROJECT NO. BER 9136-5; DATE 01-24-92; SCALE 1" = 2000'; PAGE NO.; FIGURE NO. 8

Florida Department of Environmental Regulation
Northeast District • Suite B200, 7825 Baymeadows Way • Jacksonville, Florida 32256-7577
Lawton Chiles, Governor
Carol M. Browner, Secretary

October 18, 1991

CERTIFIED - RETURN RECEIPT

Mr. Paul L. Tinkham
Pitman, Hartenstein & Ashe, Inc.
101 Century 21 Drive, Suite 207
Jacksonville, Florida 32216

Dear Mr. Tinkham:

OGC Case No. 91-0681
Berman Bros., Inc., PCAP
<u>Duval County - Waste Cleanup</u>

The Bureau of Waste Cleanup has reviewed the above PCAP and finds it adequate with the following exception. You need to submit a parameter sampling protocol including the particular methods to be used and the detection limits for each parameter.

Could you please provide this information within twenty (20) days of receipt of this letter. A PCAR will be due within 90 days of receipt of this letter.

REC'D OCT 24, 1991

Yours sincerely,

Brian S. Cheary, Ph.D.
Manager
Waste Cleanup

BSC:ddb

APPENDIX B

PITMAN • HARTENSTEIN & ASHE, INC.
ENGINEERS

October 28, 1991

Dr. Brian S. Cheary, Ph.D.
Manager Waste Cleanup
DEPARTMENT OF ENVIRONMENTAL REGULATION
Northeast District
7825 Baymeadows Way
Suite B-200
Jacksonville, Florida 32256-7577

RE: OGC Case No. 91-0681
Berman Bros., Inc. PCAP
PHA Project No. BER 9136-5

Dear Dr. Cheary:

This letter follows up our telephone conversation from this morning regarding your request for additional information on the subject in a letter received in our office on October 24, 1991.

As we discussed, the parameter sampling protocol is referenced in Integrated Environmental Solutions, Inc.'s CQAP No. 890280G. Table 3 of our PCAP submittal identifies the particular methodology and detection limits for the laboratory analysis required for each parameter. We will include this information in the PCAR submittal forthcoming in 90 days.

Best regards,
Pitman-Hartenstein & Ashe, Inc., Engineers

Paul L. Tinkham

Paul L. Tinkham
Environmental Engineer

PLT:bk

cc: Berman Bros., Inc., C. Berman
Integrated Environmental Solutions, Inc., R. Bass

INTEGRATED ENVIRONMENTAL SOLUTIONS, INC. CHAIN OF CUSTODY RECORD

Branch:

Department:

Job No.	Project Name
91209	91209

Samplers: (signature) [signature]

Station No.	Date	Time	Comp	Grab	Station Location	Number of Containers	PCBs	8 RCRA Metals					REMARKS
MW-1	12/3/91		X		MW-1	1	X	X					
MW-2	"		X		MW-2	1	X	X					
MW-3	"		X		MW-3	1	X	X					
MW-4	"		X		MW-4	1	X	X					

Relinquished by: (signature)	Date:	Time:	Received by: (signature)	Relinquished by: (signature)	Date:	Time:	Received by: (signature)
Caron Bass	12/4/91	9:50 AM	[signature]				

Relinquished by: (signature)	Date:	Time:	Received by: (signature)	Relinquished by: (signature)	Date:	Time:	Received by: (signature)

Relinquished by: (signature)	Date:	Time:	Received for Laboratory by: (signature)	Date:	Time:	Remarks
						CONTRACT T/A

DISTRIBUTION: Original and Yellow copies accompany sample shipment: Yellow copy retained by laboratory: Pink copy retained by samplers.

FIGURE 7-2

Southeastern Environmental Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS # 82315 **DHRS E-82179**

INTEGRATED ENVIRONMENTAL
SOLUTIONS, INC.
1652 EMERSON ST
JACKSONVILLE FL 32207
ATTN: ROBERT BASS

Description: 5 Samples Received on 12/05/91

Sampled By: CLIENT Client Job/PO Number: 91-209

Reference Number: 05447 Reported Date : 12/11/91
Invoice Number: 05235

Sample		Description	Client Id
0001	MW-1		91-209
0002	91-209		MW-2
0003	91-209	**INITIAL GROUND WATER SAMPLING EVENT**	MW-3
0004	91-209		MW-4
0005	91-209		EQUIPMENT BLANK

PARAMETER		SAMPLE NUMBER 0001	0002	0003
PCB'S	UG/L	< 0.7	5.0	< 0.7
PROFILE: RCRA METALS				
ARSENIC	MG/L	< 0.025	< 0.025	< 0.025
BARIUM	MG/L	0.096	0.446	0.204
CADMIUM	MG/L	< 0.025	< 0.025	< 0.025
CHROMIUM	MG/L	< 0.025	< 0.025	< 0.025
LEAD	MG/L	0.483	0.065	0.525
MERCURY	MG/L	< 0.005	< 0.005	< 0.005
SELENIUM	MG/L	< 0.025	< 0.025	< 0.025
SILVER	MG/L	< 0.025	< 0.025	< 0.025

DHRS # 82315

Southeastern Environmental Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

Reference Number: 05447

PARAMETER		SAMPLE NUMBER 0004	0005
PCB'S	UG/L	10.0	< 0.7
PROFILE: RCRA METALS			
ARSENIC	MG/L	< 0.025	< 0.025
BARIUM	MG/L	0.095	< 0.025
CADMIUM	MG/L	< 0.025	< 0.025
CHROMIUM	MG/L	< 0.025	< 0.025
LEAD	MG/L	0.044	< 0.025
MERCURY	MG/L	< 0.005	< 0.005
SELENIUM	MG/L	< 0.025	< 0.025
SILVER	MG/L	< 0.025	< 0.025

APPROVED BY: Terry L. Spaulding
Terry L. Spaulding
Laboratory Manager

DHRS # 82315

Southeastern Environmental
Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

INTEGRATED ENVIRONMENTAL
SOLUTIONS, INC.
1652 EMERSON ST
JACKSONVILLE FL 32207
ATTN: ROBERT BASS

Description: 4 Samples Received on 12/04/91

Sampled By: CLIENT Client Job/PO Number: 91-209

Reference Number: 05433 Reported Date : 12/11/91
Invoice Number: 05234

Sample		Description	Client Id
0001	91-209	SOIL SAMPLES	MW-1
0002	91-209		MW-2
0003	91-209		MW-3
0004	91-209		MW-4

PARAMETER		SAMPLE NUMBER 0001	0002	0003
PCB'S	MG/KG	< 0.1	5.0	0.4
PROFILE: RCRA METALS				
ARSENIC...	MG/KG	< 1.0	< 1.0	< 1.0
BARIUM...	MG/KG	1.08	5.10	5.14
CADMIUM...	MG/KG	< 1.0	< 1.0	< 1.0
CHROMIUM...	MG/KG	< 1.0	< 1.0	1.16
LEAD...	MG/KG	< 1.0	7.60	40.8
MERCURY...	MG/KG	< 0.50	< 0.50	< 0.50
SELENIUM...	MG/KG	< 1.0	< 1.0	< 1.0
SILVER...	MG/KG	< 1.0	< 1.0	< 1.0

DHRS # 82315

Southeastern Environmental
Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

Reference Number: 05433

PARAMETER		SAMPLE NUMBER 0004
PCB'S	MG/KG	3.0
PROFILE: RCRA METALS		
ARSENIC...	MG/KG	< 1.0
BARIUM...	MG/KG	1.78
CADMIUM...	MG/KG	< 1.0
CHROMIUM...	MG/KG	< 1.0
LEAD...	MG/KG	2.90
MERCURY...	MG/KG	< 0.50
SELENIUM...	MG/KG	< 1.0
SILVER...	MG/KG	< 1.0

APPROVED BY: Terry L. Spaulding
Terry L. Spaulding
Laboratory Manager

INTEGRATED ENVIRONMENTAL SOLUTIONS, INC.

CHAIN OF CUSTODY RECORD

Branch:

Department:

Job No.: 91-209

Project Name: 91-209

Samplers:(signature) Roger Parks

Station No.	Date	Time	Comp	Grab	Station Location	Number of Containers	Lead-filtered	Lead-unfiltered	PCB				REMARKS
MW-1	1/9/92	1330			MW-1	2	X	X					
MW-2	1/9/92	1700			MW-2	3	X	X	X				
MW-3	1/9/92	1430			MW-3	2	X	X					
MW-4	1/9/92	1600			MW-4	1			X				

Relinquished by: (signature)	Date:	Time:	Received by:(signature)	Relinquished by: (signature)	Date:	Time:	Received by:(signature)
Fred [illegible]	1-10-92	1050	[illegible]				
Relinquished by: (signature)	Date:	Time:	Received by:(signature)	Relinquished by: (signature)	Date:	Time:	Received by:(signature)

Relinquished by: (signature)	Date:	Time:	Received for Laboratory by:(signature)	Date:	Time:	Remarks

DISTRIBUTION: Original and Yellow copies accompany sample shipment; Yellow copy retained by laboratory; Pink copy retained by samplers.

DHRS # 82315

Southeastern Environmental Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

INTEGRATED ENVIRONMENTAL
SOLUTIONS, INC.
.652 EMERSON ST
JACKSONVILLE FL 32207
ATTN:

Description: 7 Samples Received on 01/10/92

Sampled By: CLIENT Client Job/PO Number: 91-209

Reference Number: 05688 Reported Date : 01/16/92
Invoice Number: 05481

Sample	Description	Client Id
0001 91-209		MW-1 (FILTERED)
0002 91-209		MW-1 (UNFILTERED)
0003 91-209		MW-2 (FILTERED)
0004 91-209	**SECOND GROUND WATER SAMPLING EVENT**	MW-2 (UNFILTERED)
0005 91-209		MW-3 (FILTERED)
0006 91-209		MW-3 (UNFILTERED)
0007 91-209		MW-4

PARAMETER		SAMPLE NUMBER 0001	0002	0003
LEAD	MG/L	< 0.025	< 0.025	< 0.025

DHRS # 82315

Southeastern Environmental Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

Reference Number: 05688 Page: 2

PARAMETER		SAMPLE NUMBER 0004	0005	0006
LEAD	MG/L	< 0.025	< 0.025	< 0.025
PCB'S	UG/L	< 0.65		

DHRS # 82315

Southeastern Environmental
Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82179

Reference Number: 05688 Page: 3

PARAMETER		SAMPLE NUMBER 0007
PCB'S	UG/L	< 0.65

APPROVED BY: Terry L. Spaulding
Terry L. Spaulding
Laboratory Manager

INTEGRATED ENVIRONMENTAL SOLUTIONS, INC. CHAIN OF CUSTODY RECORD

Branch:

Department:

Job No.	Project Name												
91209	91209												

Samplers:(signature) Rick Barr

Station No.	Date	Time	Comp	Grab	Station Location	Number of Containers	PCBs						REMARKS
01C	1/21/92	3:00		X	MW-2	4	X						

Relinquished by: (signature)	Date:	Time:	Received by:(signature)	Relinquished by: (signature)	Date:	Time:	Received by:(signature)

Relinquished by: (signature)	Date:	Time:	Received by:(signature)	Relinquished by: (signature)	Date:	Time:	Received by:(signature)
Aaron Barr							

Relinquished by: (signature)	Date:	Time:	Received for Laboratory by:(signature)	Date:	Time:	Remarks
			[illegible] / SEL	1-29-92	1100	Save extra samples for possible additional Parameters

DISTRIBUTION: Original and Yellow copies accompany sample shipment: Yellow copy retained by laboratory; Pink copy retained by samplers.

Contract T/A

FIGURE 7-2

DHRS # 82315

Southeastern Environmental
Laboratories, Inc.
80 Industrial Loop North, Building 5
Orange Park, FL 32073
(904) 269-6176

DHRS E-82

INTEGRATED ENVIRONMENTAL
SOLUTIONS, INC.
1652 EMERSON ST
JACKSONVILLE FL 32207
ATTN: ROBERT BASS

Description: 1 Sample Received on 01/29/92

Sampled By: CLIENT

Client Job/PO Number: 91-209

Reference Number: 05795

Invoice Number: 05596

Reported Date : 01/31/92

Sample	Description	Client Id
0001	91-209	MW-2

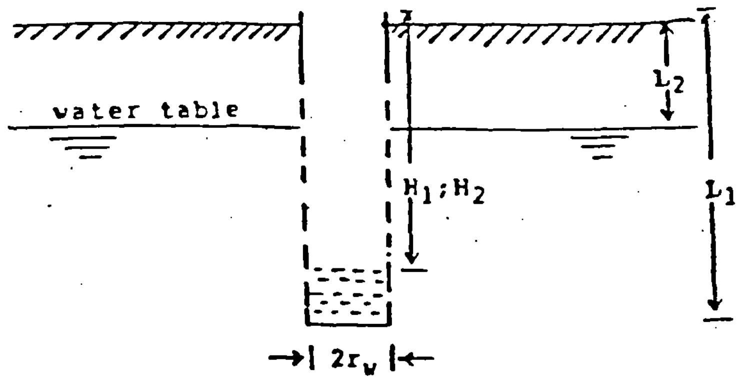
PARAMETER		SAMPLE NUMBER 0001
PCB.	MG/KG	101

APPROVED BY: Terry L. Spaulding
Terry L. Spaulding
Laboratory Manager

FIELD PERMEABILITY TEST

(RISING HEAD SLUG TEST)

FOR WELL SCREENS STARTING ABOVE THE WATER TABLE



r_w = well bore radius ....(4½" bit).......... 0.1875 ft.

L_1 = depth to screen bottom .... 16.42 ft.

L_2 = depth to top of water table .... 6.51 ft.

H_1 = depth to water in well at time t_1 .... 10.00 ft.

H_2 = depth to water in well at time t_2 .... 6.70 ft.

K = coefficient of permeability (hydraulic conductivity)

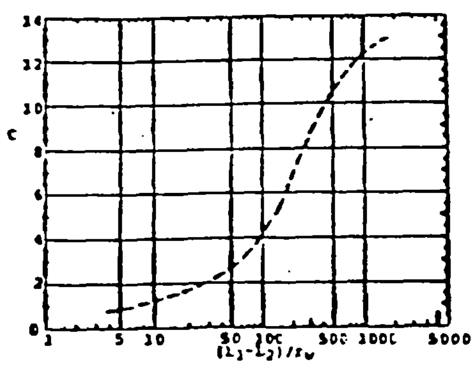
$$K = \frac{(r_w)^2\ (86,400)}{2(L_1 - L_2)\ (t_2 - t_1)} \cdot \left[\frac{1.1}{\ln\left(\frac{(L_1-L_2)}{r_w}\right)} + \frac{C}{\frac{(L_1-L_2)}{r_w}}\right]^{-1} \cdot \ln\left(\frac{H_1-L_2}{H_2-L_2}\right)$$

K = 13.86 ft./day

Bouwer and Rice updated formula (6/89) for wells screened to above the water table.

elapsed time min: sec	depth to water in well H	
0:00	11.00	
0:08	10.00	T_1
0:18	9.00	
0:33	8.00	
1:10	7.00	
1:19	6.90	
1:28	6.80	
1:46	6.70	T_2
3:15	6.60	

C=2.7



PROJECT NAME 91-209

PROJECT ADDRESS Evergreen Ave.,
Jacksonville, FL

WELL NUMBER MW-1

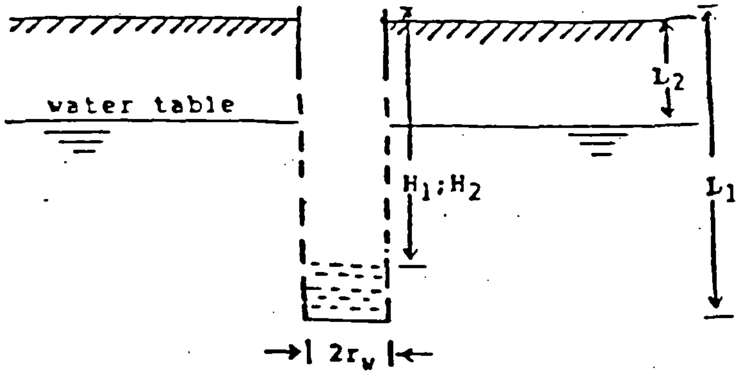
DATE 12/4/91

INTEGRATED ENVIRONMENTAL SOLUTIONS, INC.
ENVIRONMENTAL CONSULTANTS
1652 Emerson Street • Jacksonville, Florida 32207

FIELD PERMEABILITY TEST

(RISING HEAD SLUG TEST)

FOR WELL SCREENS STARTING ABOVE THE WATER TABLE



r_w = well bore radius .... (4½" bit) .... 0.1875 ft.

L_1 = depth to screen bottom .... 15.65 ft.

L_2 = depth to top of water table .... 6.76 ft.

H_1 = depth to water in well at time t_1 .... 12.50 ft.

H_2 = depth to water in well at time t_2 .... 9.00 ft.

K = coefficient of permeability (hydraulic conductivity)

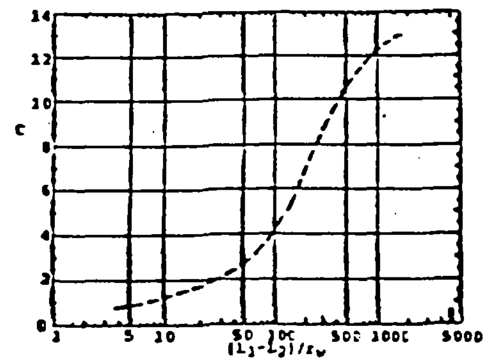
$$K = \frac{(r_w)^2\ (86{,}400)}{2(L_1 - L_2)\ (t_2 - t_1)} \cdot \left[\frac{1.1}{\ln\left(\frac{(L_1-L_2)}{r_w}\right)} + \frac{C}{\frac{(L_1-L_2)}{r_w}}\right]^{-1} \cdot \ln\left(\frac{H_1-L_2}{H_2-L_2}\right)$$

K = 8.15 ft./day

Bouwer and Rice updated formula (6/89) for wells screened to above the water table.

elapsed time min: sec	depth to water in well H	
0:00	13.00	
0:07	12.50	T_1
0:14	12.00	
0:21	11.50	
0:29	11.00	
0:37	10.50	
0:46	10.00	
0:55	9.50	
1:05	9.00	T_2
1:15	8.50	

C=2.6



PROJECT NAME 91-209

PROJECT ADDRESS Evergreen Ave.

Jacksonville, Florida

WELL NUMBER MW-2

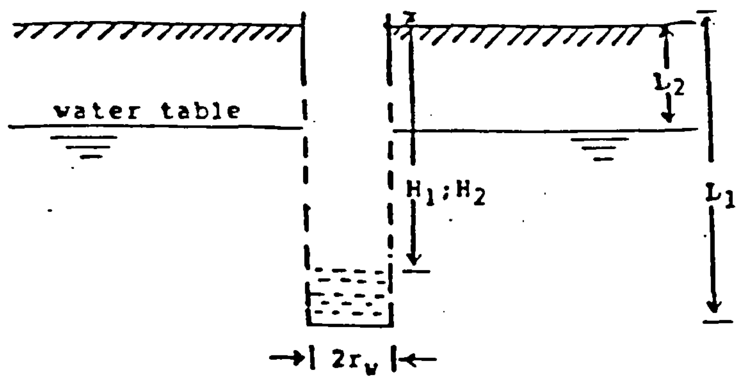
DATE 12/4/91

INTEGRATED ENVIRONMENTAL SOLUTIONS, INC.
ENVIRONMENTAL CONSULTANTS
1652 Emerson Street • Jacksonville, Florida 32207

FIELD PERMEABILITY TEST

(RISING HEAD SLUG TEST)

FOR WELL SCREENS STARTING ABOVE THE WATER TABLE



r_w = well bore radius .... 0.1875 ft.

L_1 = depth to screen bottom ....15.05 ft.

L_2 = depth to top of water table .... 8.04 ft.

H_1 = depth to water in well at time t_1 ....12.00 ft.

H_2 = depth to water in well at time t_2 .... 9.00 ft.

K = coefficient of permeability (hydraulic conductivity)

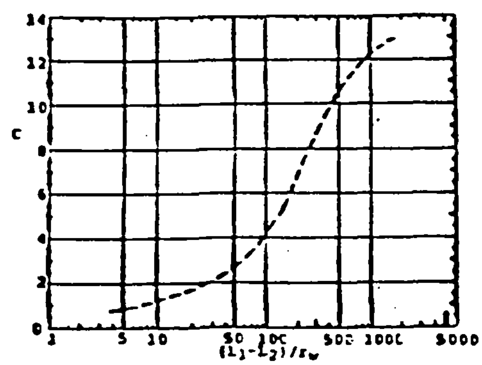
$$K = \frac{(r_w)^2\ (86{,}400)}{2(L_1 - L_2)\ (t_2-t_1)} \cdot \left[\frac{1.1}{\ln\left(\frac{(L_1-L_2)}{r_w}\right)} + \frac{C}{\frac{(L_1-L_2)}{r_w}}\right]^{-1} \cdot \ln\left(\frac{H_1-L_2}{H_2-L_2}\right)$$

K = 8.63 ft./day

Bouwer and Rice updated formula (6/89) for wells screened to above the water table.

elapsed time min: sec	depth to water in well H	
0:00	13.00	
0:11	12.50	
0:21	12.00	T_1
0:34	11.50	
0:47	11.00	
1:00	10.50	
1:16	10.00	
1:33	9.50	
1:57	9.00	T_2
2:51	8.50	

C=2.5



PROJECT NAME 91-209

PROJECT ADDRESS Evergreen Ave.

Jacksonville, FL

WELL NUMBER MW-3

DATE 12/4/91

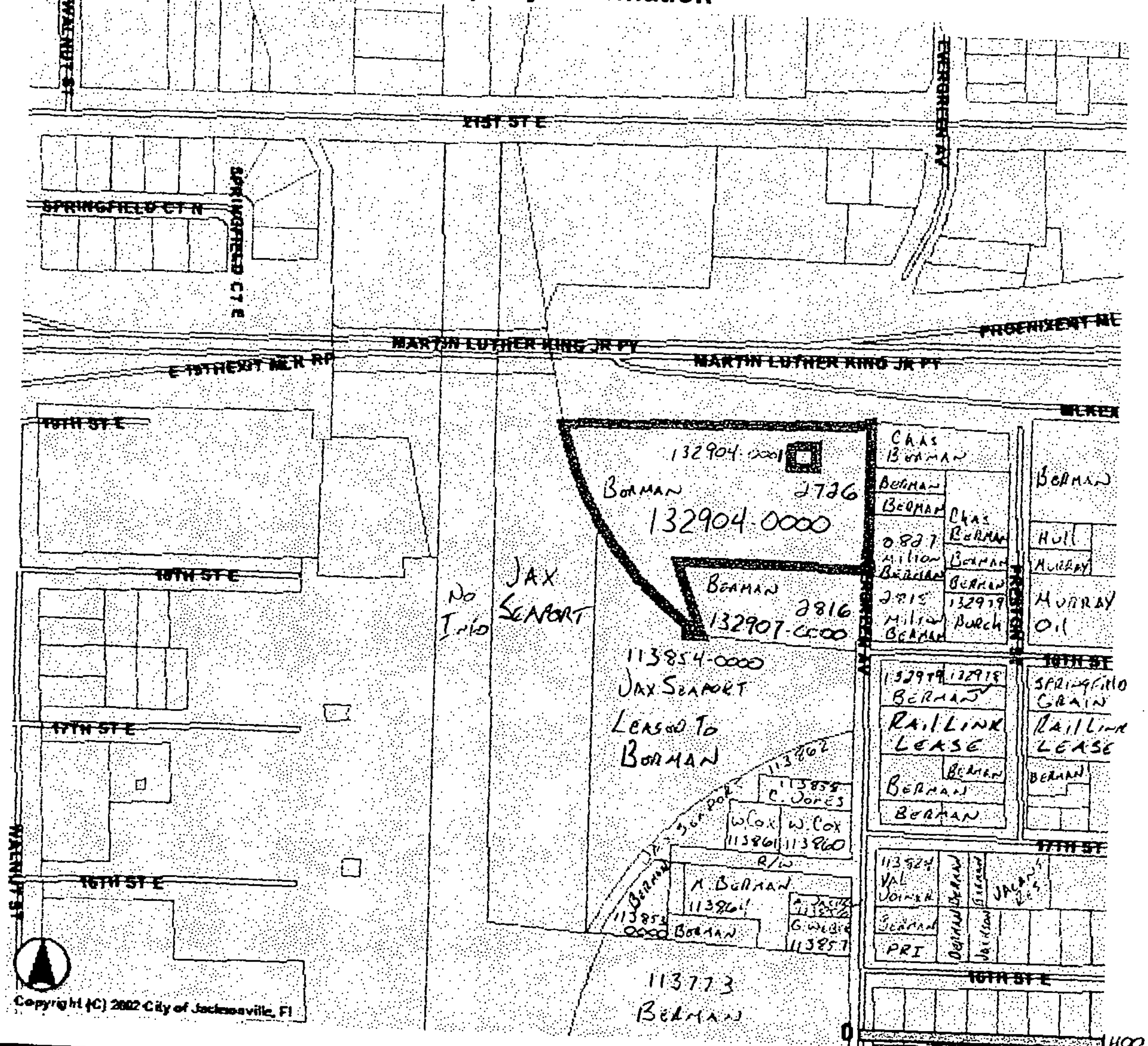
INTEGRATED ENVIRONMENTAL SOLUTIONS, INC.

ENVIRONMENTAL CONSULTANTS

1652 Emerson Street • Jacksonville, Florida 32207

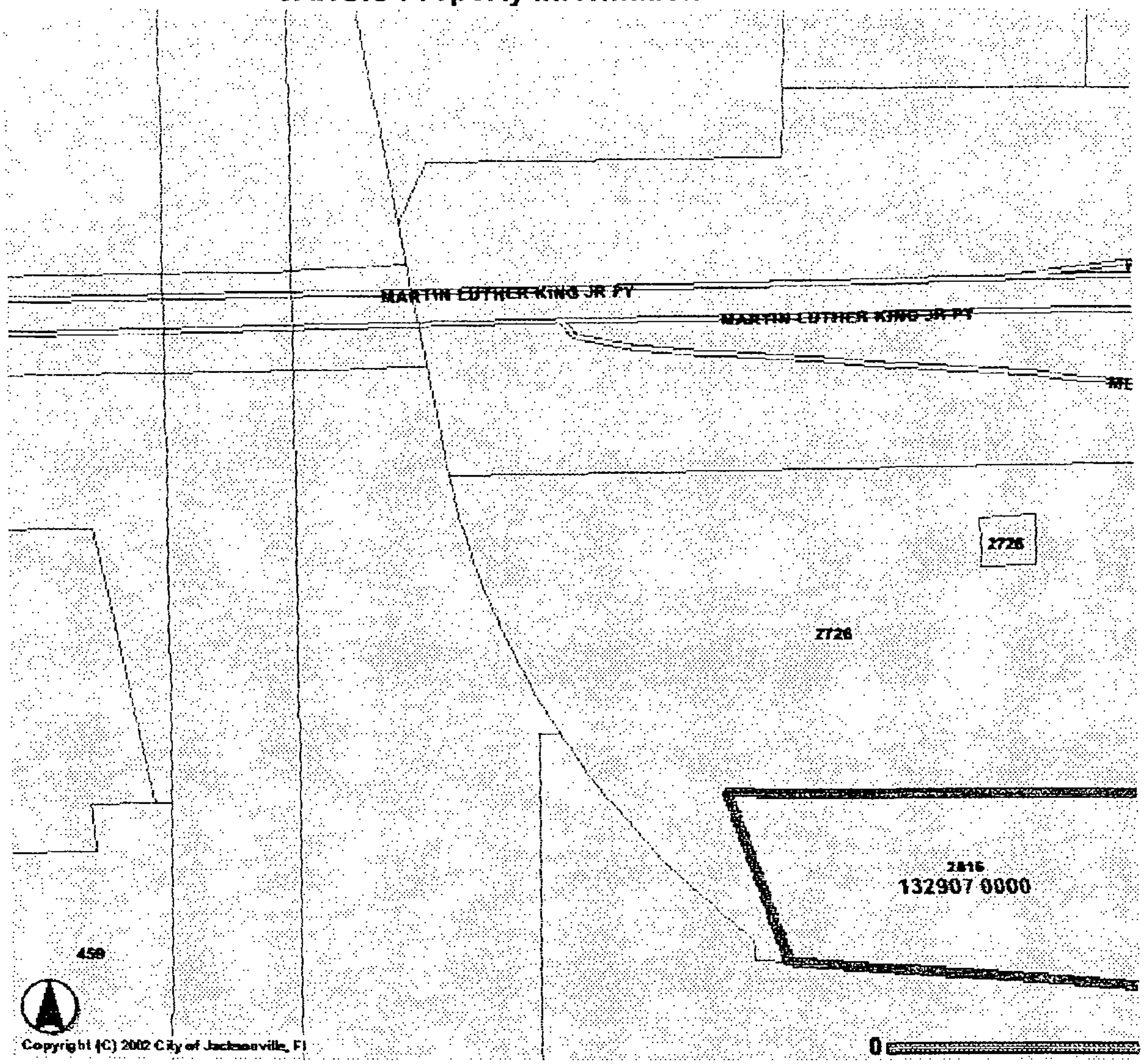
Reference 7

JAXGIS Property Information



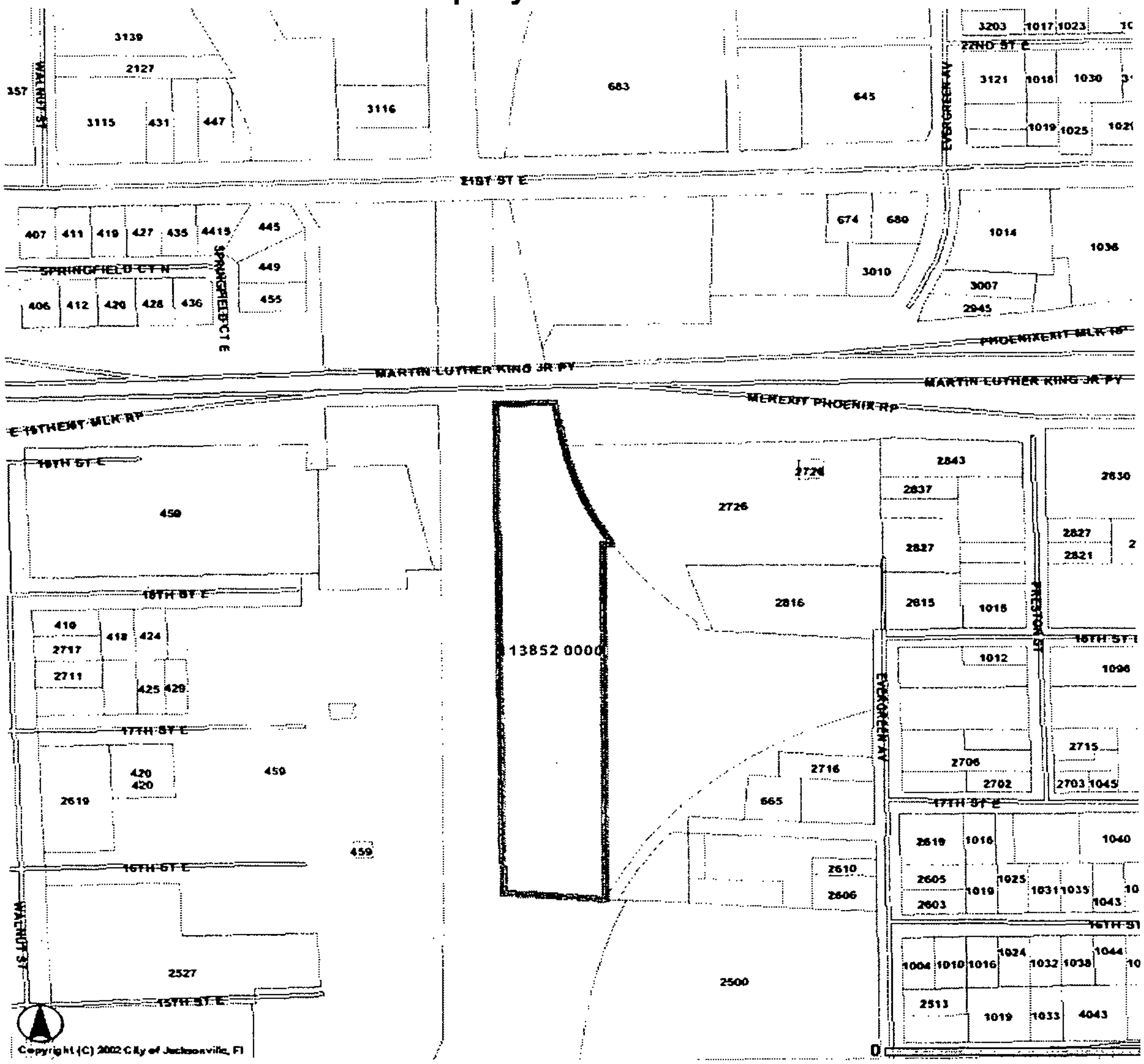
RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zoning
132904 0000	BERMAN MILTON	2726 EVERGREEN AV 32206	965208	2.61	000H	386 2	AH-526 46-2S-27E 2.61 LONG BRANCH PT LOT 9 RECD O/R 3192-162,	NO	LI	IL

JAXGIS Property Information



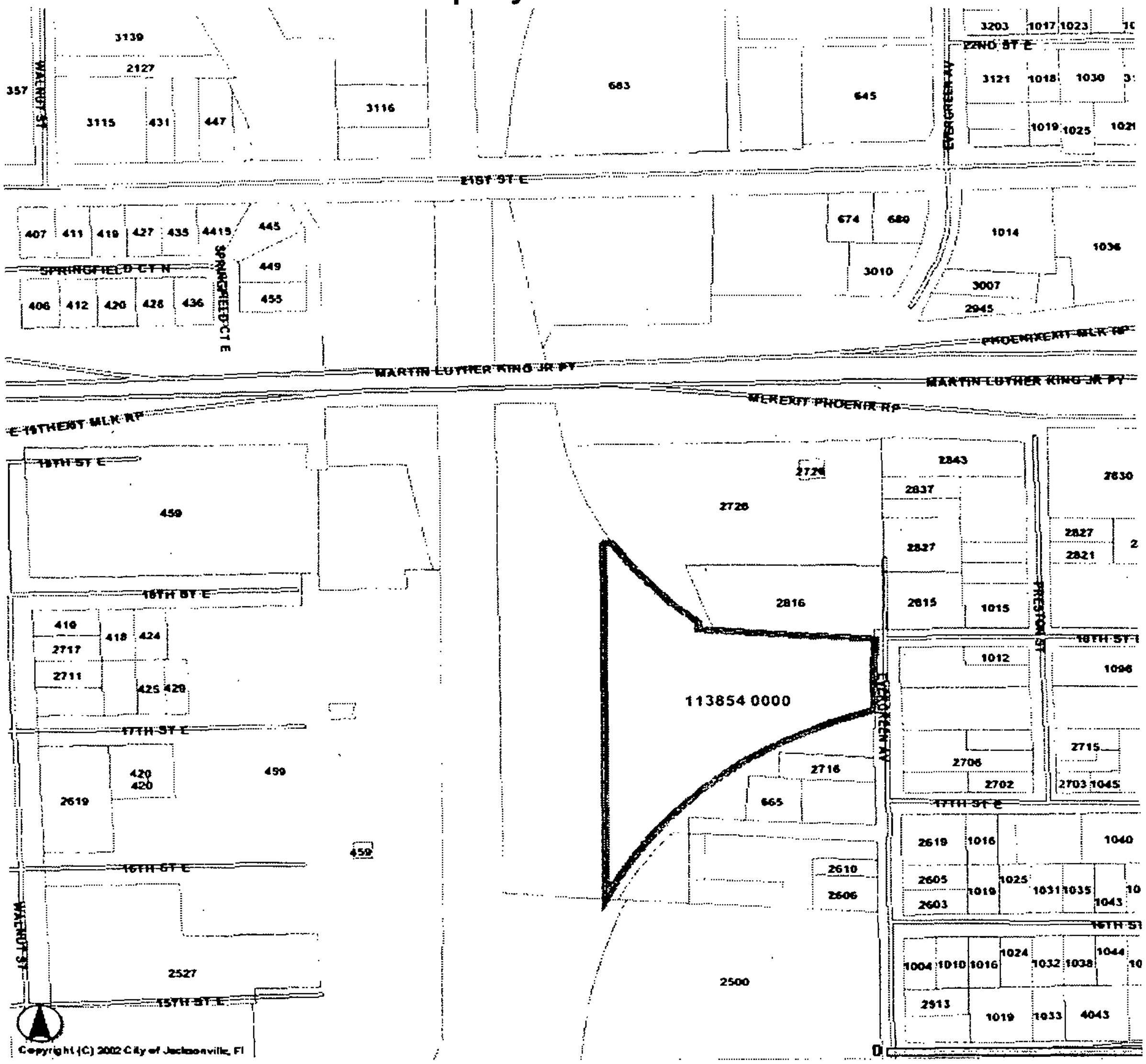
RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zoning
132907 0000	BERMAN MILTON ET AL	2816 EVERGREEN AV 32206	30428	0.93	000H	386 2	AH-526 06-2S-27E .931 LONG BRANCH PT LOT 9 RECD O/R 2799-414,N1/2	NO	HI	IL

JAXGIS Property Information



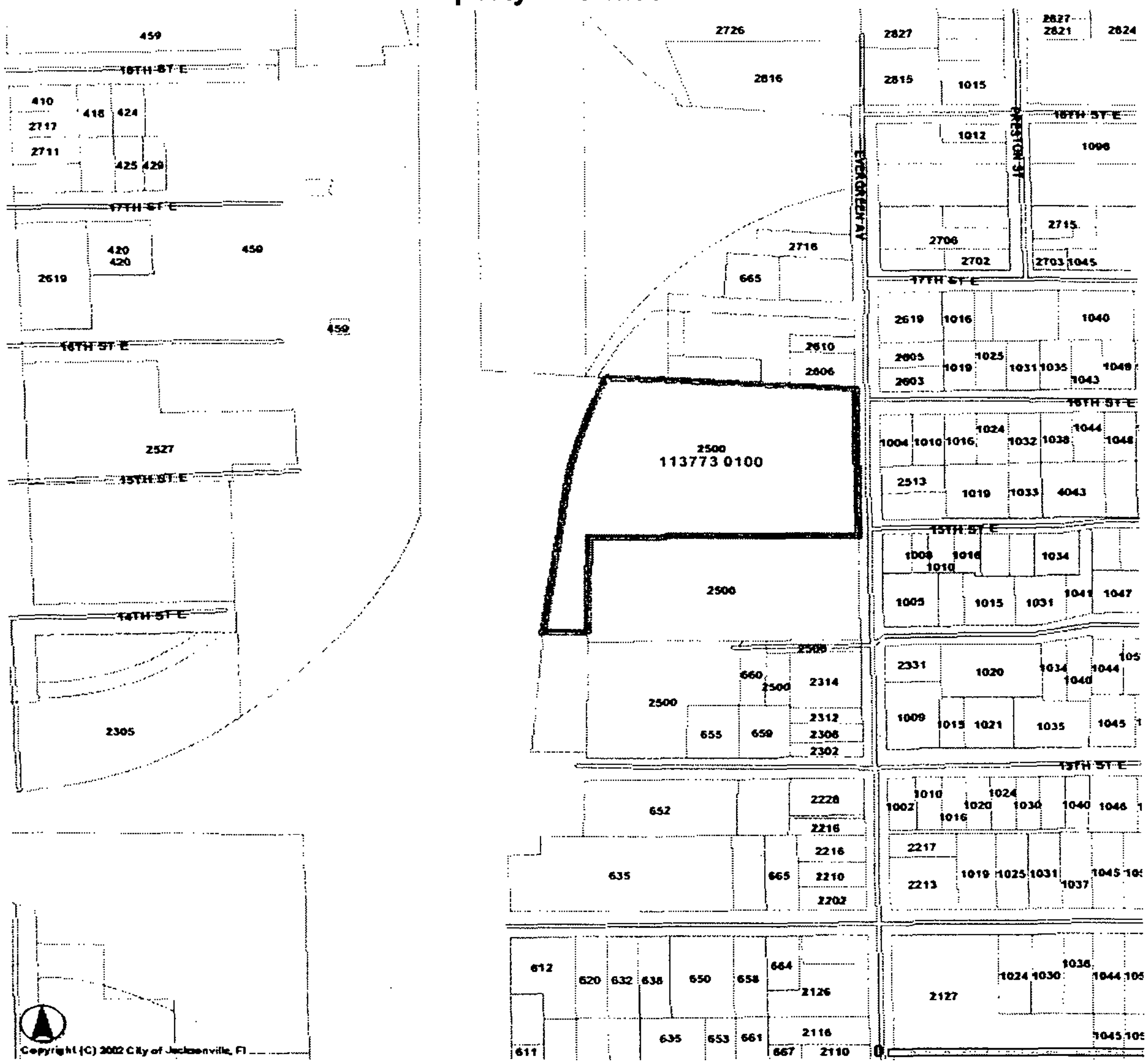
RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zonin
113852 0000	JACKSONVILLE SEAPORT AUTHORITY	EVERGREEN AV 32206	124146	3.8	000A	386 3	1-52 06-2S-27E 3.80 EVANS S/D LOTS 1 TO 10, (EX W 60FT) BLK A,	Not in Flood Zone	HI	IH

JAXGIS Property Information



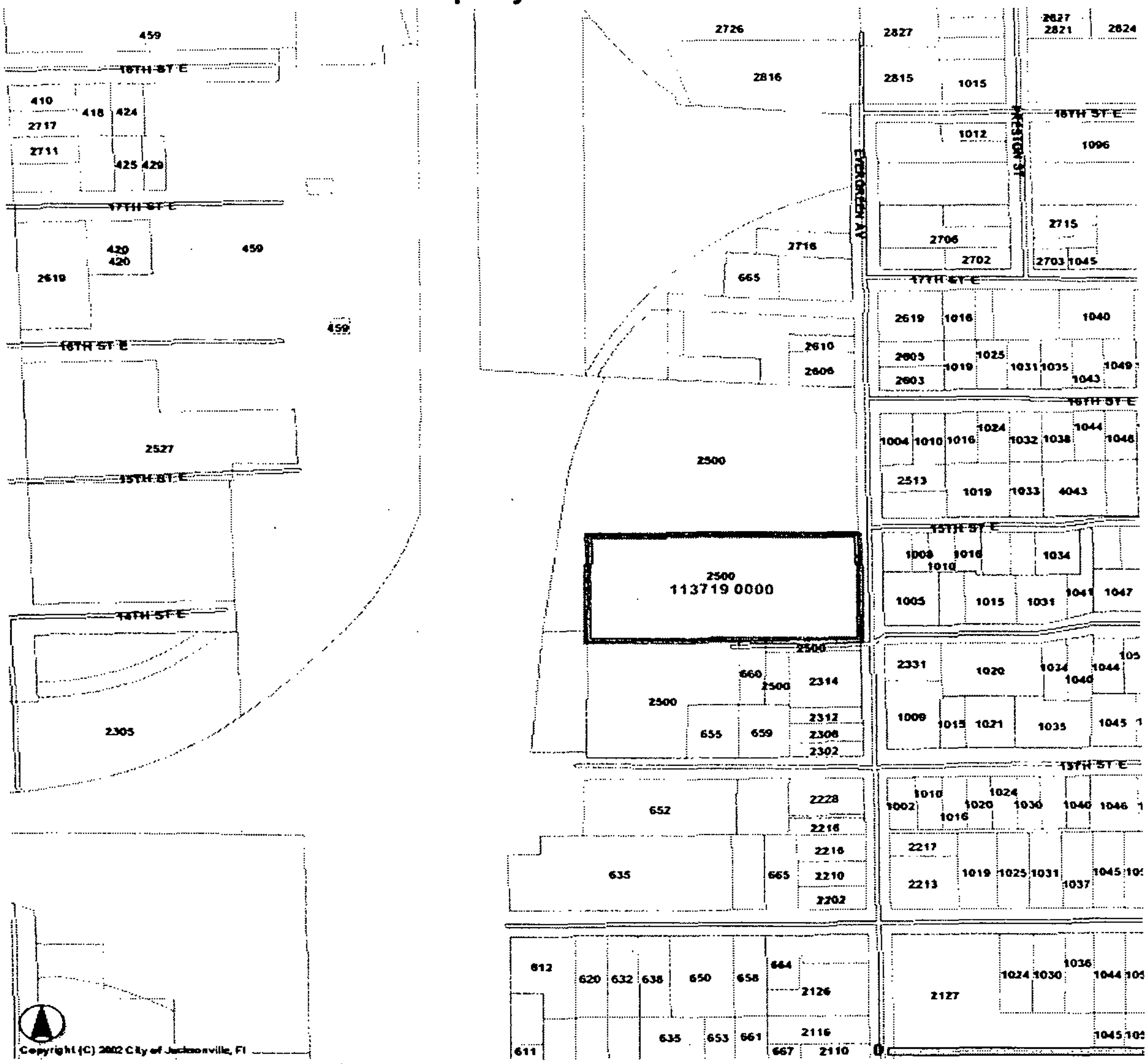
RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	Landl
113854 0000	JACKSONVILLE SEAPORT AUTHORITY	EVERGREEN AV 32206	96050	2.94	000A	386 3	1-52 06-2S-27E 2.94 EVANS S/D PT LOTS 11 TO 20 BLK A,	Not in Flood Zone	HI

JAXGIS Property Information



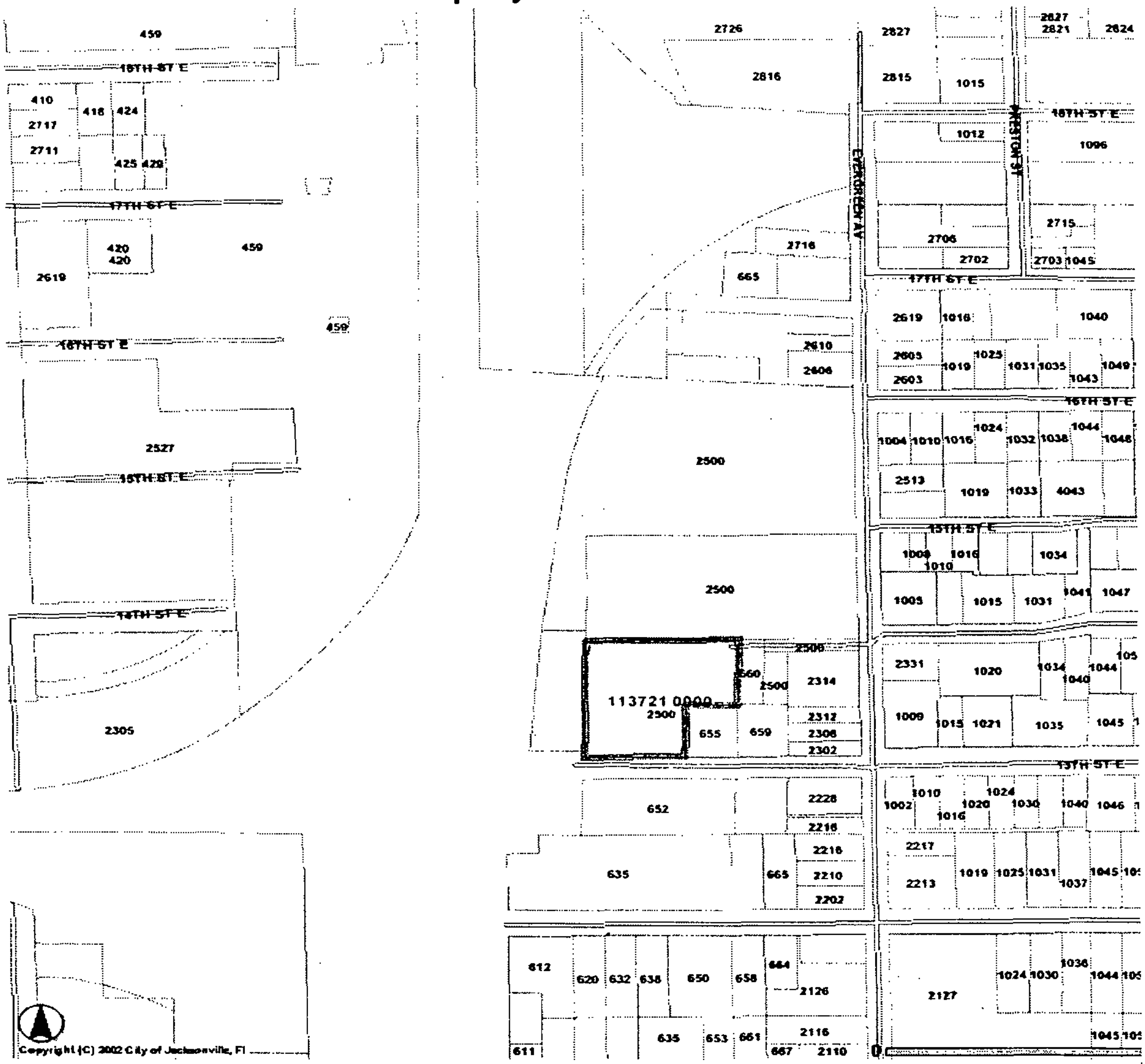
RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zoning	ENT
113773 0100	BERMAN MILTON ET AL	2500 EVERGREEN AV 32206	292597	3.14	0000	386 3	06-2S-27E PT GOVT LOT 4 RECD O/R BK 6660-0204 CHARLES BERMAN	Not in Flood Zone	LI	IL	ENT

JAXGIS Property Information



RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zoning	ENT
113719 0000	BERMAN MILTON ET AL	2500 EVERGREEN AV 32206	63704	1.95	0001	386 3	03-013 06-2S-27E SPRINGFIELD ANNEX BLK 1, PT CL ST RECD O/R BK 6660 204	Not in Flood Zone	LI	IL	ENT

JAXGIS Property Information



RE #	Name	Address	Total Value	Acres	Plat Book	Map Panel	Legal Descriptions	Flood Zone	LandUse	Zoning	ENT
113721 0000	BERMAN MILTON ET AL	2500 EVERGREEN AV 32206	192906	1.14	0002	386 3	03-013 06-2S-27E SPRINGFIELD ANNEX LOTS 3,5 TO 14,PT CLOSED ST BLK 2	Not in Flood Zone	LI	IL	ENT

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	132904 0000		
Owner's Name:	BERMAN , MILTON		
Property Address:	2726 EVERGREEN AV	Unit No.	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206-0065	
Property Use:	4895 WAREHOUSE, SHELL		
Legal description:	AH-526 46-2S-27E 2.61 LONG BRANCH PT LOT 9 RECD O/R 3192-162,		
	3715-230,3789-880,W1/2 STREET LYING E THEREOF CLOSED BY O/R 6575-664 BLK H		
Neighborhood:	002393 LONG BRANCH BLK H COMM	Sec-Twn-Range:	06-2S-27E
OR BK & Page:	06575-0664	Map Panel:	386 2
Sale Date:	9/7/1988	No. Buildings:	2
Sale Price:	$100.00	Heated Area:	99802
		Exterior Wall:	MODULAR METAL

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$56,846.00		
Class Value:	$0.00		
Improvements:	$929,001.00	Taxing Authority:	USD1
Market Value:	$985,847.00	County Tax:	$6,816.70
Assessed Value:	$985,847.00	School Tax:	$5,605.59
Exempt Value:	$315,242.00	District Tax:	$0.00
Taxable Value:	$670,605.00	Other Tax:	$335.64
Sr. Exempt:	$0.00	Voted Tax:	$389.09
Sr. Taxable:	$0.00	Total Tax:	$13,147.02

This page displays values from the 2002 Certified Tax Roll with weekly updates of ownership & sales.

Map-It maps & data are not updated as frequently as the Tax Roll data and may not reflect matching information.
Please direct inquiries regarding the maps & data to Map-It Feedback (below).

Map-It Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	132904 0001		
Owner's Name:	BERMAN , MILTON		
Property Address:	2726 EVERGREEN AV	Unit No.	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206-0065	
Property Use:	4895 WAREHOUSE, SHELL		
Legal description:	AH-526 46-2S-27E 2.61 LONG BRANCH PT LOT 9 RECD O/R 3192-162,		
	3715-230,3789-880,W1/2 STREET LYING E THEREOF CLOSED BY O/R 6575-664 BLK H		
Neighborhood:	002393 LONG BRANCH BLK H COMM	Sec-Twn-Range:	06-2S-27E
OR BK & Page:	06575-0664	Map Panel:	386 2
Sale Date:	9/7/1988	No. Buildings:	2
Sale Price:	$100.00	Heated Area:	99802
		Exterior Wall:	MODULAR METAL

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$0.00		
Class Value:	$0.00		
Improvements:	$315,242.00	Taxing Authority:	USD1R
Market Value:	$315,242.00	County Tax:	$0.00
Assessed Value:	$315,242.00	School Tax:	$2,635.11
Exempt Value:	$0.00	District Tax:	$0.00
Taxable Value:	$315,242.00	Other Tax:	$157.78
Sr. Exempt:	$0.00	Voted Tax:	$182.90
Sr. Taxable:	$0.00	Total Tax:	$2,975.79

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Map-It Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly

RE No.:	132907 0000		
Owner's Name:	BERMAN , MILTON ET AL		
Property Address:	2816 EVERGREEN AV	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206-0065	
Property Use:	4895 WAREHOUSE, SHELL		
Legal description:	AH-526 06-2S-27E .931 LONG BRANCH PT LOT 9 RECD O/R 2799-414,N1/2		
	& W1/2 CLOSED STREETS LYING ADJACENT THERETO BLK H		
Neighborhood:	002393 LONG BRANCH BLK H COMM	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06575-0664	**Map Panel:**	386 2
Sale Date:	9/7/1988	**No. Buildings:**	0
Sale Price:	$100.00	**Heated Area:**	0
		Exterior Wall:	

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll

Land Value:	$30,428.00		
Class Value:	$0.00		
Improvements:	$0.00	**Taxing Authority:**	USD1
Market Value:	$30,428.00	**County Tax:**	$309.30
Assessed Value:	$30,428.00	**School Tax:**	$254.35
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$30,428.00	**Other Tax:**	$15.23
Sr. Exempt:	$0.00	**Voted Tax:**	$17.65
Sr. Taxable:	$0.00	**Total Tax:**	$596.53

This page displays values from the 2002 Certified Tax Roll with weekly updates of ownership & sales.

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Please direct inquiries regarding the maps & data to Map-It Feedback (below).

Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113854 0000		
Owner's Name:	JACKSONVILLE SEAPORT AUTHORITY,		
Property Address:	EVERGREEN AV	Unit No.	
	JACKSONVILLE	32206	
Mailing Address:	2831 TALLEYRAND AV		
	JACKSONVILLE , FL	32206-3417	
Property Use:	9000 LEASEHOLD INT		
Legal description:	1-52 06-2S-27E 2.94 EVANS S/D PT LOTS 11 TO 20 BLK A,		
	LOTS 1 TO 4,PT LOT 5 BLK B, 5-61 EVANS R/P PT LOTS 5,6,7,PT CL ST ORD FF-606,		
Neighborhood:	740801 TALLEYRAND JPA	Sec-Twn-Range:	06-2S-27E
OR BK & Page:	02170-0418	Map Panel:	386 3
Sale Date:	5/1/1964	No. Buildings:	0
Sale Price:	$0.00	Heated Area:	0
		Exterior Wall:	
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$96,050.00		
Class Value:	$0.00		
Improvements:	$0.00	Taxing Authority:	USD1
Market Value:	$96,050.00	County Tax:	$976.35
Assessed Value:	$96,050.00	School Tax:	$802.89
Exempt Value:	$0.00	District Tax:	$0.00
Taxable Value:	$96,050.00	Other Tax:	$48.08
Sr. Exempt:	$0.00	Voted Tax:	$55.72
Sr. Taxable:	$0.00	Total Tax:	$1,883.04

This page displays values from the 2002 Certified Tax Roll with weekly updates of ownership & sales.

Map-It maps & data are not updated as frequently as the Tax Roll data and may not reflect matching information.
Please direct inquiries regarding the maps & data to Map-It Feedback (below).

Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Duval County 2002		REQUESTED BY: Z ZIPPERER RUN 10/04/2002 01:07	
1-52 06-2S-27E	2.94		JACKSONVILLE SEAPORT AUTHORITY
EVANS S/D			2831 TALLEYRAND AV
PT LOTS 11 TO 20	BLK A,		JACKSONVILLE, FL 32206-0005
LOTS 1 TO 4,PT LOT 5	BLK B,		
5-61 EVANS R/P			

PROPERTY NOTES :

7/24/02 HCG LEASED TO BERMAN
BROTHERS AS OPEN STORAGE, BLDG
PARTLY DEMOD NVA.

REC	BLDG	CODE	DESC	LENGTH	WIDTH	UNITS	ADJ PRICE

REC	LUSE	DESC	ZONING	FRONTAGE	DEPTH	UNITS	TP	ACRES
1	9000	LEASEHOLD INTEREST	IH	.00	.00	128066	S	2.93

Property Record Cards are updated annually.
Contact City Zoning at 904-630-1086 for the most current zoning.

Map-It Feedback Payment Feedback Appraisal Feedback

Home New Map-IT Taxes

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113861 0000		
Owner's Name:	COX , WILLIAM F		
Property Address:	665 17TH ST E	**Unit No.**	
	JACKSONVILLE		
Mailing Address:	1648 AVANT RD		
	YULEE , FL	32097-4800	
Property Use:	4000 VACANT INDUS		
Legal description:	05-061 06-2S-27E EVANS R/P W 9FT OF LOT 1 & LOTS 2,3,4		
Neighborhood:	002011 EVANS S/D R/P COMM	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06121-0839	**Map Panel:**	386 3
Sale Date:	4/21/1986	**No. Buildings:**	0
Sale Price:	$100.00	**Heated Area:**	0
		Exterior Wall:	
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$6,054.00		
Class Value:	$0.00		
Improvements:	$300.00	**Taxing Authority:**	USD1
Market Value:	$6,354.00	**County Tax:**	$64.59
Assessed Value:	$6,354.00	**School Tax:**	$53.12
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$6,354.00	**Other Tax:**	$3.18
Sr. Exempt:	$0.00	**Voted Tax:**	$3.68
Sr. Taxable:	$0.00	**Total Tax:**	$124.57

This page displays values from the 2002 Certified Tax Roll with weekly updates of ownership & sales.

Map-It maps & data are not updated as frequently as the Tax Roll data and may not reflect matching information.
Please direct inquiries regarding the maps & data to Map-It Feedback (below).

Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113860 0000		
Owner's Name:	COX , WILLIAM F		
Property Address:	17TH ST E	**Unit No.**	
	JACKSONVILLE	32299	
Mailing Address:	1648 AVANT RD		
	YULEE , FL	32097-4800	
Property Use:	4000 VACANT INDUS		
Legal description:	05-061 06-2S-27E EVANS R/P LOT 1(EX W 9FT),LOTS 16,17,18		
	O/R BK 4941-1071 LIFE ESTATE O/R BK 6723-2344		
Neighborhood:	740401 EVANS S/D & RP BLK B	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06121-0839	**Map Panel:**	386 3
Sale Date:	4/21/1986	**No. Buildings:**	0
Sale Price:	$100.00	**Heated Area:**	0
		Exterior Wall:	

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$6,919.00		
Class Value:	$0.00		
Improvements:	$1,400.00	**Taxing Authority:**	USD1
Market Value:	$8,319.00	**County Tax:**	$84.56
Assessed Value:	$8,319.00	**School Tax:**	$69.54
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$8,319.00	**Other Tax:**	$4.16
Sr. Exempt:	$0.00	**Voted Tax:**	$4.83
Sr. Taxable:	$0.00	**Total Tax:**	$163.09

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113862 0000		
Owner's Name:	JACKSONVILLE SEAPORT AUTHORITY,		
Property Address:	EVERGREEN AV	Unit No.	
	JACKSONVILLE	32206	
Mailing Address:	2831 TALLEYRAND AV		
	JACKSONVILLE , FL	32206-3417	
Property Use:	9000 LEASEHOLD INT		
Legal description:	1-52 06-2S-27E .51 EVANS S/D PT LOTS 11,12,13 RECD O/R 2170-418		
	BEING PARCEL 2A BLK A, LOT 5 BLK B, 5-61 EVANS R/P		
Neighborhood:	740801 TALLEYRAND JPA	Sec-Twn-Range:	06-2S-27E
OR BK & Page:	02170-0418	Map Panel:	386 3
Sale Date:	5/1/1964	No. Buildings:	0
Sale Price:	$0.00	Heated Area:	0
		Exterior Wall:	
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$0.00		
Class Value:	$0.00		
Improvements:	$0.00	Taxing Authority:	9999
Market Value:	$0.00	County Tax:	$0.00
Assessed Value:	$0.00	School Tax:	$0.00
Exempt Value:	$0.00	District Tax:	$0.00
Taxable Value:	$0.00	Other Tax:	$0.00
Sr. Exempt:	$0.00	Voted Tax:	$0.00
Sr. Taxable:	$0.00	Total Tax:	$0.00

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly

RE No.:	113858 0000		
Owner's Name:	JONES , CHARLES E		
Property Address:	2716 EVERGREEN ST	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	2716 EVERGREEN AV		
	JACKSONVILLE , FL	32206-0544	
Property Use:	1292 RES/COMM ZONING		
Legal description:	01-052 06-2S-27E EVANS S/D LOT 16 BLK B		
	O/R BK 5912-347		
Neighborhood:	740401 EVANS S/D & RP BLK B	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	05912-0347	**Map Panel:**	386 3
Sale Date:	2/3/1985	**No. Buildings:**	1
Sale Price:	$5,000.00	**Heated Area:**	1160
		Exterior Wall:	WOOD SHEATH/PLY

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll

Land Value:	$5,519.00		
Class Value:	$0.00		
Improvements:	$6,870.00	**Taxing Authority:**	USD1
Market Value:	$12,389.00	**County Tax:**	$0.00
Assessed Value:	$11,958.00	**School Tax:**	$0.00
Exempt Value:	$11,958.00	**District Tax:**	$0.00
Taxable Value:	$0.00	**Other Tax:**	$0.00
Sr. Exempt:	$0.00	**Voted Tax:**	$0.00
Sr. Taxable:	$0.00	**Total Tax:**	$0.00

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly

RE No.:	113856 0000		
Owner's Name:	JACKSON , ARTHUR W ET AL		
Property Address:	2610 EVERGREEN AV	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	152 W 32ND ST		
	JACKSONVILLE , FL	32206-6425	
Property Use:	1292 RES/COMM ZONING		
Legal description:	01-052 06-2S-27E EVANS S/D N 33.5FT OF E 100FT LOT 12		
	BLK B BETTY J JACKSON O/R BK 6148-668		
Neighborhood:	740401 EVANS S/D & RP BLK B	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06148-0668	**Map Panel:**	386 3
Sale Date:	6/10/1986	**No. Buildings:**	1
Sale Price:	$5,000.00	**Heated Area:**	846
		Exterior Wall:	WOOD SHEATH/PLY
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$2,513.00		
Class Value:	$0.00		
Improvements:	$5,270.00	**Taxing Authority:**	USD1
Market Value:	$7,783.00	**County Tax:**	$79.11
Assessed Value:	$7,783.00	**School Tax:**	$65.06
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$7,783.00	**Other Tax:**	$3.90
Sr. Exempt:	$0.00	**Voted Tax:**	$4.52
Sr. Taxable:	$0.00	**Total Tax:**	$152.59

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	132973 0000		
Owner's Name:	BURCH , KENNITH		
Property Address:	1015 18TH ST E	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 28239		
	JACKSONVILLE , FL	32226-8239	
Property Use:	4895 WAREHOUSE, SHELL		
Legal description:	3-88 06-2S-27E HIGHLAND PARK S/D LOT 10 BLK H LONG BRANCH		
	LOT 7,LOT 8(EX W 2FT) BLK C		
Neighborhood:	002398 HIGHLAND PARK S/D	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	07954-2152	**Map Panel:**	386 2
Sale Date:	10/12/1994	**No. Buildings:**	0
Sale Price:	$13,500.00	**Heated Area:**	0
		Exterior Wall:	
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$6,150.00		
Class Value:	$0.00		
Improvements:	$0.00	**Taxing Authority:**	USD1
Market Value:	$6,150.00	**County Tax:**	$62.51
Assessed Value:	$6,150.00	**School Tax:**	$51.41
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$6,150.00	**Other Tax:**	$3.08
Sr. Exempt:	$0.00	**Voted Tax:**	$3.57
Sr. Taxable:	$0.00	**Total Tax:**	$120.57

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	132981 0000		
Owner's Name:	BERMAN , FLORANCE WOLFSON ET AL		
Property Address:		**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206-0065	
Property Use:	4000 VACANT INDUS		
Legal description:	3-88 06-2S-27E HIGHLAND PARK S/D LOT 5 BLK D		
Neighborhood:	002398 HIGHLANDS PK S/D COMM	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	09864-0057	**Map Panel:**	386 3
Sale Date:	1/25/2001	**No. Buildings:**	0
Sale Price:	$100.00	**Heated Area:**	0
		Exterior Wall:	
Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$3,000.00		
Class Value:	$0.00		
Improvements:	$0.00	**Taxing Authority:**	USD1
Market Value:	$3,000.00	**County Tax:**	$30.50
Assessed Value:	$3,000.00	**School Tax:**	$25.08
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$3,000.00	**Other Tax:**	$1.51
Sr. Exempt:	$0.00	**Voted Tax:**	$1.74
Sr. Taxable:	$0.00	**Total Tax:**	$58.83

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113824 0000		
Owner's Name:	JOINER , VAL G		
Property Address:	2619 EVERGREEN AV	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	2619 EVERGREEN AV		
	JACKSONVILLE , FL	32206-3128	
Property Use:	0100 SINGLE FAMILY		
Legal description:	2-13 06-2S-27E .230 J HAGANS S/D PT LOT 4 LOTS 9,10 BLK 1		
Neighborhood:	002009 HAGANS, J. S/D	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	05141-0214	**Map Panel:**	386 3
Sale Date:	6/27/1980	**No. Buildings:**	1
Sale Price:	$5,000.00	**Heated Area:**	1128
		Exterior Wall:	CONCRETE BLOCK

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$11,125.00		
Class Value:	$0.00		
Improvements:	$19,500.00	**Taxing Authority:**	USD1
Market Value:	$30,625.00	**County Tax:**	$0.00
Assessed Value:	$7,103.00	**School Tax:**	$0.00
Exempt Value:	$7,103.00	**District Tax:**	$0.00
Taxable Value:	$0.00	**Other Tax:**	$0.00
Sr. Exempt:	$0.00	**Voted Tax:**	$0.00
Sr. Taxable:	$0.00	**Total Tax:**	$0.00

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113825 0000		
Owner's Name:	BERMAN , MILTON ET AL		
Property Address:	2605 EVERGREEN AV	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	2726 EVERGREEN AVE		
	JACKSONVILLE , FL	32206-3131	
Property Use:	0000 VACANT RES		
Legal description:	02-013 06-2S-27E J HAGANS S/D PT LOT 4 LOT 11 BLOCK 1		
	CHARLES BERMAN O/R BK 6660-204 ERIC BERMAN		
Neighborhood:	002009 HAGANS, J. S/D	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06660-0204	**Map Panel:**	386 3
Sale Date:	2/17/1989	**No. Buildings:**	0
Sale Price:	$425,000.00	**Heated Area:**	0
		Exterior Wall:	

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$5,563.00		
Class Value:	$0.00		
Improvements:	$0.00	**Taxing Authority:**	USD1
Market Value:	$5,563.00	**County Tax:**	$56.55
Assessed Value:	$5,563.00	**School Tax:**	$46.50
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$5,563.00	**Other Tax:**	$2.78
Sr. Exempt:	$0.00	**Voted Tax:**	$3.23
Sr. Taxable:	$0.00	**Total Tax:**	$109.06

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	113827 0000		
Owner's Name:	BERMAN , CHARLES ET AL		
Property Address:	1019 16TH ST E	**Unit No.**	
	JACKSONVILLE	32208	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206	
Property Use:	0100 SINGLE FAMILY		
Legal description:	2-13 06-2S-27E J HAGANS S/D PT LOT 4 LOT 13 BLK 1		
Neighborhood:	002009 HAGANS, J. S/D	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	10693-2257	**Map Panel:**	386 3
Sale Date:	9/19/2002	**No. Buildings:**	1
Sale Price:	$67,000.00	**Heated Area:**	1064
		Exterior Wall:	WOOD SHEATH/PLY

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$6,125.00		
Class Value:	$0.00		
Improvements:	$12,400.00	**Taxing Authority:**	USD1
Market Value:	$18,525.00	**County Tax:**	$188.31
Assessed Value:	$18,525.00	**School Tax:**	$154.85
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$18,525.00	**Other Tax:**	$9.27
Sr. Exempt:	$0.00	**Voted Tax:**	$10.75
Sr. Taxable:	$0.00	**Total Tax:**	$363.18

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

Parcel Summary - Current Ownership and Sale Information - Updated Weekly			
RE No.:	132954 0000		
Owner's Name:	BERMAN , CHARLES ET AL		
Property Address:	2830 FLORIDA AV	**Unit No.**	
	JACKSONVILLE	32206	
Mailing Address:	P O BOX 3065		
	JACKSONVILLE , FL	32206-0065	
Property Use:	1700 OFFICE 1-2 STY		
Legal description:	03-088 06-2S-27E HIGHLAND PARK S/D PT LOT 10 BLK H LOTS 1,2,3,9,10,11 BLK A		
	THE ANTIOCH S/D LOTS 12,13,PT CL ST ORD # 55-515		
Neighborhood:	002398 HIGHLANDS PK S/D COMM	**Sec-Twn-Range:**	06-2S-27E
OR BK & Page:	06174-2141	**Map Panel:**	386 2
Sale Date:	8/5/1986	**No. Buildings:**	1
Sale Price:	$150,000.00	**Heated Area:**	1920
		Exterior Wall:	CONCRETE BLOCK

Parcel Summary- Values & Taxes from the 2002 Certified Tax Roll			
Land Value:	$28,557.00		
Class Value:	$0.00		
Improvements:	$47,069.00	**Taxing Authority:**	USD1
Market Value:	$75,626.00	**County Tax:**	$768.74
Assessed Value:	$75,626.00	**School Tax:**	$632.16
Exempt Value:	$0.00	**District Tax:**	$0.00
Taxable Value:	$75,626.00	**Other Tax:**	$37.85
Sr. Exempt:	$0.00	**Voted Tax:**	$43.88
Sr. Taxable:	$0.00	**Total Tax:**	$1,482.63

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Home PRC New Map-IT Taxes

Map-It Feedback

Payment Feedback

Appraisal Feedback

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site index

Soil Samples
11-20
Property Info.

Property Appraiser

Parcel Information 11-55

Owner's Name: JOINER , VAL G **Secondary Name:** MARY F	**Real Estate Number:** 113824 0000

Property Address: 2619 EVERGREEN AV

City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 2619 EVERGREEN AV
JACKSONVILLE , FL
Zip: 32206-3128

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 6/27/1980**
Legal Description: 2-13 06-2S-27E .230 J HAGANS S/D PT LOT 4 LOTS 9,10 BLK 1 -	**Sale Price:** $5,000.00
Neighborhood: 002009 HAGANS, J. S/D	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 05141-0214	**Heated Area:** 1128
Map Panel: 386 3	**Exterior Wall:** CONCRETE BLOCK

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $11,125.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $0.00
Improvements: $20,200.00	**School Tax:** $0.00
Market Value: $31,325.00	**District Tax:** $0.00
Assessed Value: $7,273.00	**Other Tax:** $0.00
Exempt Value: $7,273.00	**Voted Tax:** $0.00

PARCEL INFORMATION

Owner's Name: ALMARAZ , JEREMY	**Real Estate Number:** 113843 0000

Property Address: 1004 16TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1004 16TH ST E
JACKSONVILLE , FL
Zip:
32206-3115

PARCEL DESCRIPTION

12 · 55

Property Use: 0100 SINGLE FAMILY	**Sale Date: 9/22/2003**
Legal Description: 2-13 06-2S-27E J HAGANS S/D PT LOT 4 W 1/2 LOTS 9,10 BLK 2 -	**Sale Price:** $26,900.00
Neighborhood: 002009 HAGANS, J. S/D	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 11375-2463	**Heated Area:** 704
Map Panel: 386 3	**Exterior Wall:** CONCRETE BLOCK

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $5,563.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $198.40
Improvements: $14,600.00	**School Tax:** $172.19
Market Value: $20,163.00	**District Tax:** $0.00
Assessed Value: $20,163.00	**Other Tax:** $10.10
Exempt Value: $0.00	**Voted Tax:** $10.30
Taxable Value: $20,163.00	
Sr. Exempt: $0.00	
Sr. Taxable: $0.00	**Total Tax:** $390.99

Property Appraiser

Parcel Information

13.55

Owner's Name: BRUNKE , GERALD **Secondary Name:**	**Real Estate Number:** 113755 0000

Property Address: 1016 15TH ST E
City: JACKSONVILLE
Zip: 32239
Unit Number:

Mailing Address: 150 E 11TH ST
JACKSONVILLE , FL
Zip: 32206-3720

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 1/6/1985**
Legal Description: 06-2S-27E SPRINGFIELD ANNEX E 30.3FT LOT 4,W 8.7FT LOT 5 BLK 5 - ELIZABETH O/R BK 5932-116	**Sale Price:** $10,000.00
Neighborhood: 002006 SPRINGFIELD ANNEX	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 05932-0116	**Heated Area:** 648
Map Panel: 386 3	**Exterior Wall:** SINGLE SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $3,900.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $132.84
Improvements: $9,600.00	**School Tax:** $115.29
Market Value: $13,500.00	**District Tax:** $0.00
Assessed Value: $13,500.00	**Other Tax:** $6.76

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site index | contact | search

Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 14-55

Owner's Name: SHARPE , CHARLES DANIEL **Secondary Name:**	**Real Estate Number:** 113762 0000

Property Address: 1015 14TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1015 E 14TH ST
JACKSONVILLE , FL
Zip: 32206-3109

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 6/10/1992**
Legal Description: 6-48 06-2S-27E SPRINGFIELD ANNEX LOTS 12,13 BLK 5 -	**Sale Price:** $100.00
Neighborhood: 002006 SPRINGFIELD ANNEX	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 07354-2127	**Heated Area:** 336
Map Panel: 386 3	**Exterior Wall:** SINGLE SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $8,600.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $0.00
Improvements: $14,000.00	**School Tax:** $0.00
Market Value: $22,600.00	**District Tax:** $0.00
Assessed Value: $14,466.00	**Other Tax:** $0.00
Exempt Value: $14,466.00	**Voted Tax:** $0.00

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site index contact search

Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 15.55

Owner's Name: WILLIAMSON , GROVER C LIFE ESTATE **Secondary Name:** HATTIE	**Real Estate Number:** 113776 0000

Property Address: 2732 PHOENIX AV
City: JACKSONVILLE
Zip: 32206
Unit Number: 1

Mailing Address: 2732 PHOENIX AVE
JACKSONVILLE , FL
Zip: 32206-3147

PARCEL DESCRIPTION

Property Use: 1292 RES/COMM ZONING	**Sale Date: 7/9/1999**
Legal Description: 06-2S-27E .16 PT GOVT LOT 4 RECD O/R 9386-1168 -	**Sale Price:** $100.00
Neighborhood: 000000 SECTION LAND COMM	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 09386-1168	**Heated Area:** 1098
Map Panel: 386 3	**Exterior Wall:** ALUMINUM SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $3,267.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $12.08
Improvements: $28,628.00	**School Tax:** $48.35
Market Value: $31,895.00	**District Tax:** $0.00
Assessed Value: $30,662.00	**Other Tax:** $2.84

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site index contact search

Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 16.55

Owner's Name: MILLARD , ESTELLE COX LIFE ESTATE **Secondary Name:**	**Real Estate Number:** 113760 0000

Property Address: 1041 14TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1041 E 14TH ST
JACKSONVILLE , FL
Zip: 32206-3109

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 2/5/2001**
Legal Description: 6-48 06-2S-27E .11 SPRINGFIELD ANNEX E 19FT OF LOT 8,LOT 9 BLK 5 -	**Sale Price:** $100.00
Neighborhood: 002006 SPRINGFIELD ANNEX	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 09876-1785	**Heated Area:** 884
Map Panel: 386 3	**Exterior Wall:** SINGLE SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $4,883.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $0.00
Improvements: $33,700.00	**School Tax:** $0.00
Market Value: $38,583.00	**District Tax:** $0.00

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site index | contact | search

Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 17.55

Owner's Name: WALTHOUR , ROBERT L **Secondary Name:**	**Real Estate Number:** 113633 0000

Property Address: 1125 19TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1125 E 19TH ST
JACKSONVILLE , FL
Zip: 32206-3222

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 10/31/1979**
Legal Description: 02-008 06-2S-27E HARTRIDGES ADDN TO EAST SPRINGFIELD LOTS 7,9 BLK 13 - GWENDOLYN L O/R BK 4994-365	**Sale Price:** $21,900.00
Neighborhood: 002002 HARTRIDGES ADDN TO EAST	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 04994-0365	**Heated Area:** 1248
Map Panel: 386 1	**Exterior Wall:** WOOD SHEATH/PLY

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $15,000.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $183.49
Improvements: $46,928.00	**School Tax:** $159.26
Market Value: $61,928.00	**District Tax:** $0.00

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Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 18.55

Owner's Name: WELLS , ARTHUR J **Secondary Name:**	**Real Estate Number:** 113600 0000

Property Address: 1125 18TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1125 E 18TH ST
JACKSONVILLE , FL
Zip: 32206-3218

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 3/17/1986**
Legal Description: 02-008 06-2S-27E HARTRIDGES ADDN TO EAST SPRINGFIELD LOT 7 BLK 11 - CAROLYN SUE O/R BK 6248-112	**Sale Price:** $15,000.00
Neighborhood: 002002 HARTRIDGES ADDN TO EAST	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 06248-0112	**Heated Area:** 1316
Map Panel: 386 1	**Exterior Wall:** SINGLE SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $6,250.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $0.00
Improvements: $18,028.00	**School Tax:** $0.00
Market Value: $24,278.00	**District Tax:** $0.00

Property Appraiser

Parcel Information 19-55

Owner's Name: MINER , W A **Secondary Name:**	**Real Estate Number:** 113551 0000

Property Address: 1117 16TH ST E
City: JACKSONVILLE
Zip: 32210
Unit Number:

Mailing Address: 5036 SANIBEL DR
JACKSONVILLE , FL
Zip: 32210-7445

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 6/12/1991**
Legal Description: 02-008 06-2S-27E HARTRIDGES ADDN TO EAST SPRINGFIELD W 37 1/2 FT LOT 5 BLK 7 - O/R BK 7150-1270 0	**Sale Price:** $100.00
Neighborhood: 002002 HARTRIDGES ADDN TO EAST	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 07150-1270	**Heated Area:** 1227
Map Panel: 386 4	**Exterior Wall:** ALUMINUM SIDING

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $4,228.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $387.96
Improvements: $35,200.00	**School Tax:** $336.71
Market Value: $39,428.00	**District Tax:** $0.00
Assessed Value: $39,428.00	**Other Tax:** $19.74

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Property Appraiser

Home > Departments > Property Appraiser > Duval County Database Search

Parcel Information 20-55

Owner's Name: COSTANTINI , LAURA D **Secondary Name:**	**Real Estate Number:** 113482 0000

Property Address: 1131 14TH ST E
City: JACKSONVILLE
Zip: 32206
Unit Number:

Mailing Address: 1131 E 14TH ST
JACKSONVILLE , FL
Zip: 32206-3203

PARCEL DESCRIPTION

Property Use: 0100 SINGLE FAMILY	**Sale Date: 5/30/1980**
Legal Description: 06-2S-27E HARTRIDGES ADDN TO EAST SPRINGFIELD LOT 9 BLOCK 3 - CA: 91-11417	**Sale Price:** $18,500.00
Neighborhood: 002002 HARTRIDGES ADDN TO EAST	
Section/Township/Range: 06-2S-27E	**No. Buildings:** 1
Official Record Book and Page: 05121-0913	**Heated Area:** 1116
Map Panel: 386 4	**Exterior Wall:** WOOD SHEATH/PLY

VALUES AND TAXES FROM 2003 CERTIFIED TAX ROLL

Land Value: $5,563.00	**Taxing Authority:** USD1
Class Value: $0.00	**County Tax:** $0.00
Improvements: $13,028.00	**School Tax:** $0.00
Market Value: $18,591.00	**District Tax:** $0.00
Assessed Value: $13,439.00	**Other Tax:** $0.00

JACKSONVILLE WSO AP, FLORIDA

Period of Record General Climate Summary - Temperature

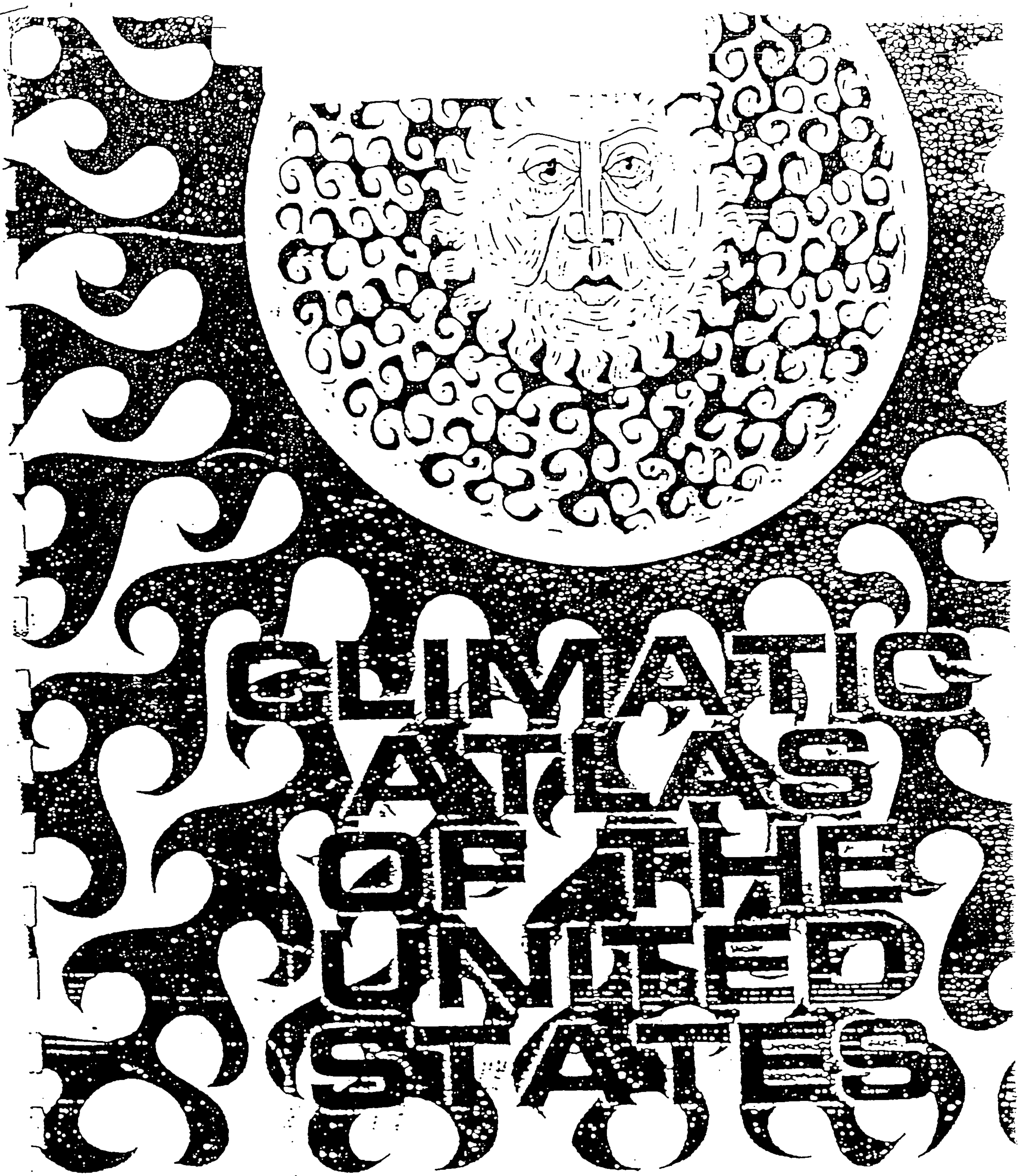
Station:(084358) JACKSONVILLE WSO AP															
From Year=1948 To Year=2003															
	Monthly Averages			Daily Extremes				Monthly Extremes				Max. Temp.		Min. Temp.	
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90 F	<= 32 F	<= 32 F	<= 0 F
	F	F	F	F	dd/yyyy or yyyymmdd	F	dd/yyyy or yyyymmdd	F	-	F	-	# Days	# Days	# Days	# Days
January	65.0	42.6	53.8	84	29/1957	7	21/1985	66.7	74	44.0	***	0.0	0.0	6.2	0.0
February	67.9	45.2	56.6	88	24/1962	19	05/1996	65.2	49	47.5	***	0.0	0.0	3.4	0.0
March	73.7	50.4	62.0	91	12/1967	23	03/1980	67.9	61	55.4	***	0.1	0.0	0.8	0.0
April	79.8	56.3	68.0	95	21/1968	34	01/1987	73.0	68	62.6	83	1.4	0.0	0.0	0.0
May	85.9	63.7	74.8	100	13/1967	45	04/1971	80.6	53	71.4	76	8.1	0.0	0.0	0.0
June	89.8	70.1	80.0	103	27/1950	47	01/1984	84.5	52	75.8	66	16.2	0.0	0.0	0.0
July	92.0	72.8	82.4	103	17/1981	61	08/1972	84.4	81	78.9	74	23.7	0.0	0.0	0.0
August	90.9	72.6	81.7	102	05/1954	59	12/2000	84.9	54	79.1	96	20.7	0.0	0.0	0.0
September	87.1	70.1	78.6	98	02/1970	48	19/1981	81.3	70	75.3	101	9.9	0.0	0.0	0.0
October	80.2	60.7	70.4	96	06/1951	36	18/1977	76.4	49	63.9	87	1.2	0.0	0.0	0.0
November	72.9	50.8	61.9	88	01/1961	21	25/1970	69.9	48	54.2	76	0.0	0.0	0.9	0.0
December	66.4	44.2	55.3	84	23/1956	11	25/1983	64.3	71	47.7	89	0.0	0.0	4.4	0.0
Annual	79.3	58.3	68.8	103	19500627	7	19850121	71.4	49	66.2	76	81.3	0.0	15.7	0.0
Winter	66.5	44.0	55.2	88	19620224	7	19850121	62.3	50	48.9	77	0.0	0.0	14.0	0.0

Reference 8

Spring	79.8	56.8	68.3	100	19670513	23	19800303	72.1	91	64.3	83	9.6	0.0	0.8	0.0
Summer	90.9	71.9	81.4	103	19500627	47	19840601	83.6	54	78.7	74	60.6	0.0	0.0	0.0
Fall	80.1	60.5	70.3	98	19700902	21	19701125	74.2	85	65.2	76	11.1	0.0	0.9	0.0

Table updated on Oct 14,
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons
Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Southeast Regional Climate Center, sercc@dnr.state.sc.us



onmental Science Services Administration . Environment

U.S. DEPARTMENT OF COMMERCE
C. R. Smith, Secretary

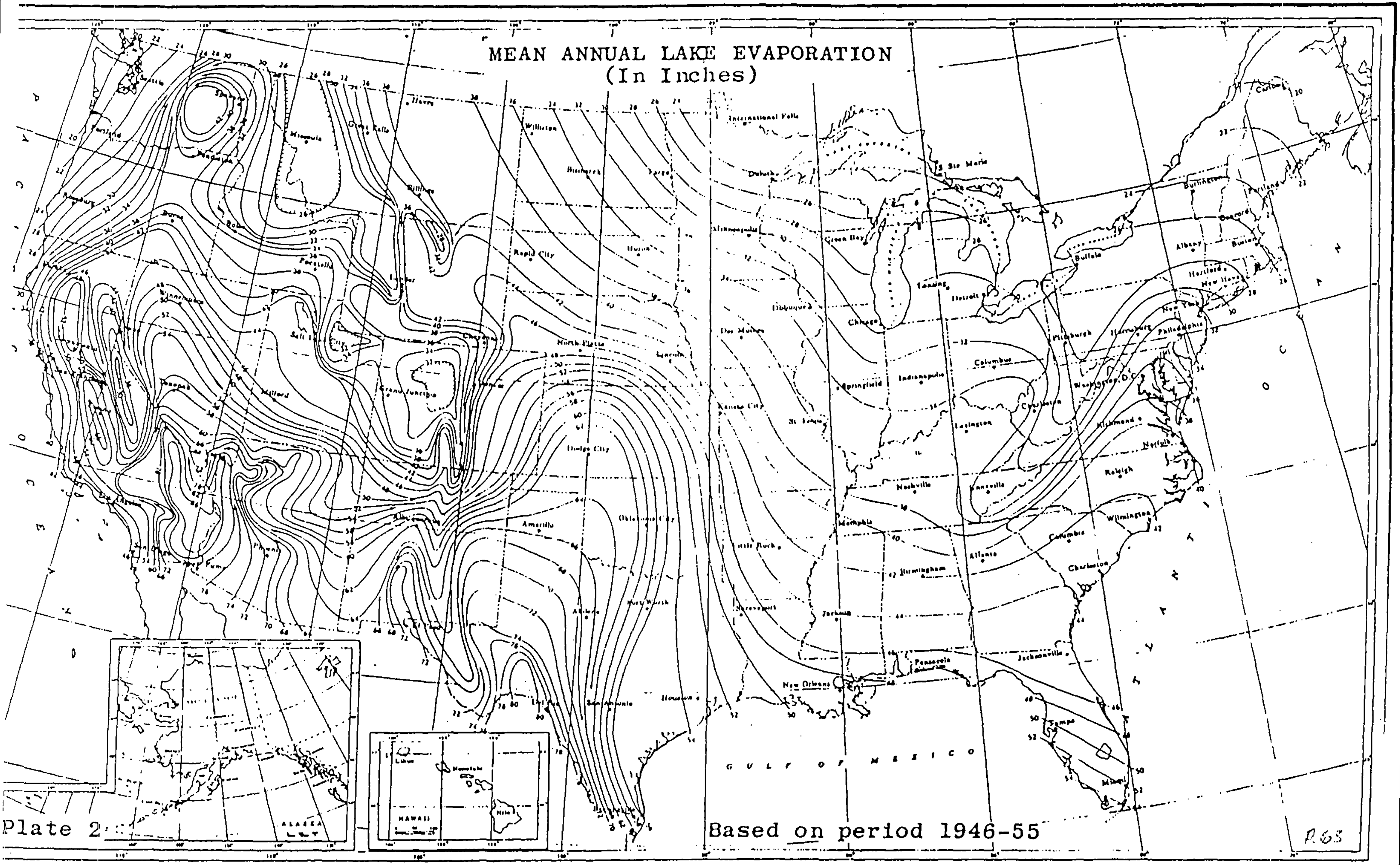
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
Robert M. White, Administrator

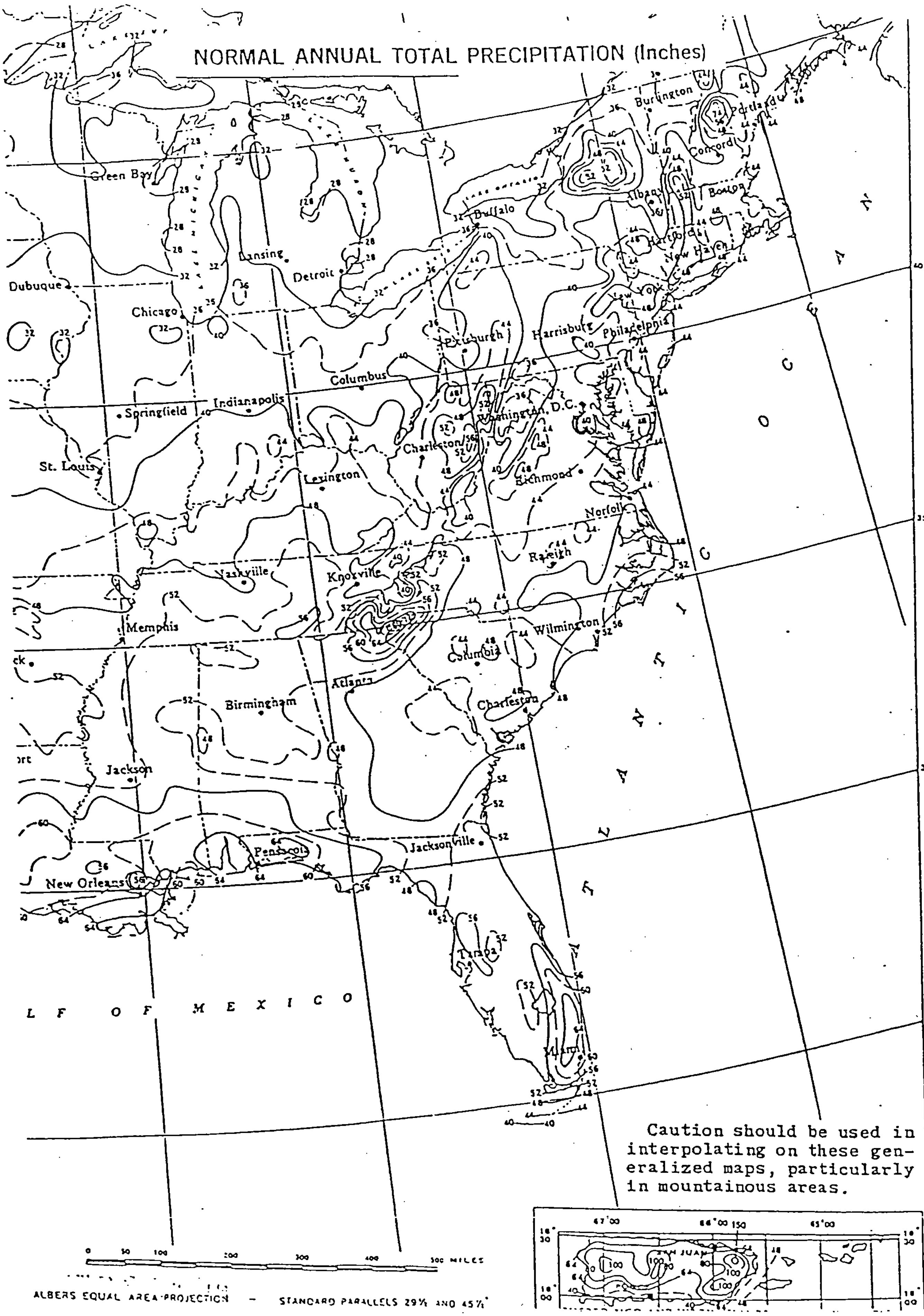
ENVIRONMENTAL DATA SERVICE
Woodrow C. Jacobs, Director

JUNE 1968

REPRINTED BY THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
1983

ıKE EVAPORATION




NORMAL ANNUAL TOTAL PRECIPITATION (Inches)
Green Bay
Burlington
Portland
Concord
Albany
Boston
Buffalo
Hartford
New Haven
Lansing
Detroit
Dubuque
Chicago
New York
Pittsburgh
Harrisburg
Philadelphia
Columbus
Indianapolis
Springfield
Washington, D.C.
Charleston
St. Louis
Lexington
Richmond
Norfolk
Raleigh
Nashville
Knoxville
Memphis
Wilmington
Columbia
Atlanta
Birmingham
Charleston
Jackson
Jacksonville
Pensacola
New Orleans
Tampa
Miami
GULF OF MEXICO
ATLANTIC OCEAN
Caution should be used in interpolating on these generalized maps, particularly in mountainous areas.
0 50 100 200 300 400 500 MILES
ALBERS EQUAL AREA PROJECTION — STANDARD PARALLELS 29½ AND 45½


PREVAILING DIRECTION AND MEAN SPEED (M.P.H.) OF WIND
ANNUAL
ALASKA
HAWAII
GULF OF MEXICO
ATLANTIC OCEAN
PACIFIC OCEAN
NOTE:
Arrows fly with wind.

OMMERCE

WEATHE
F. W. Reic

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

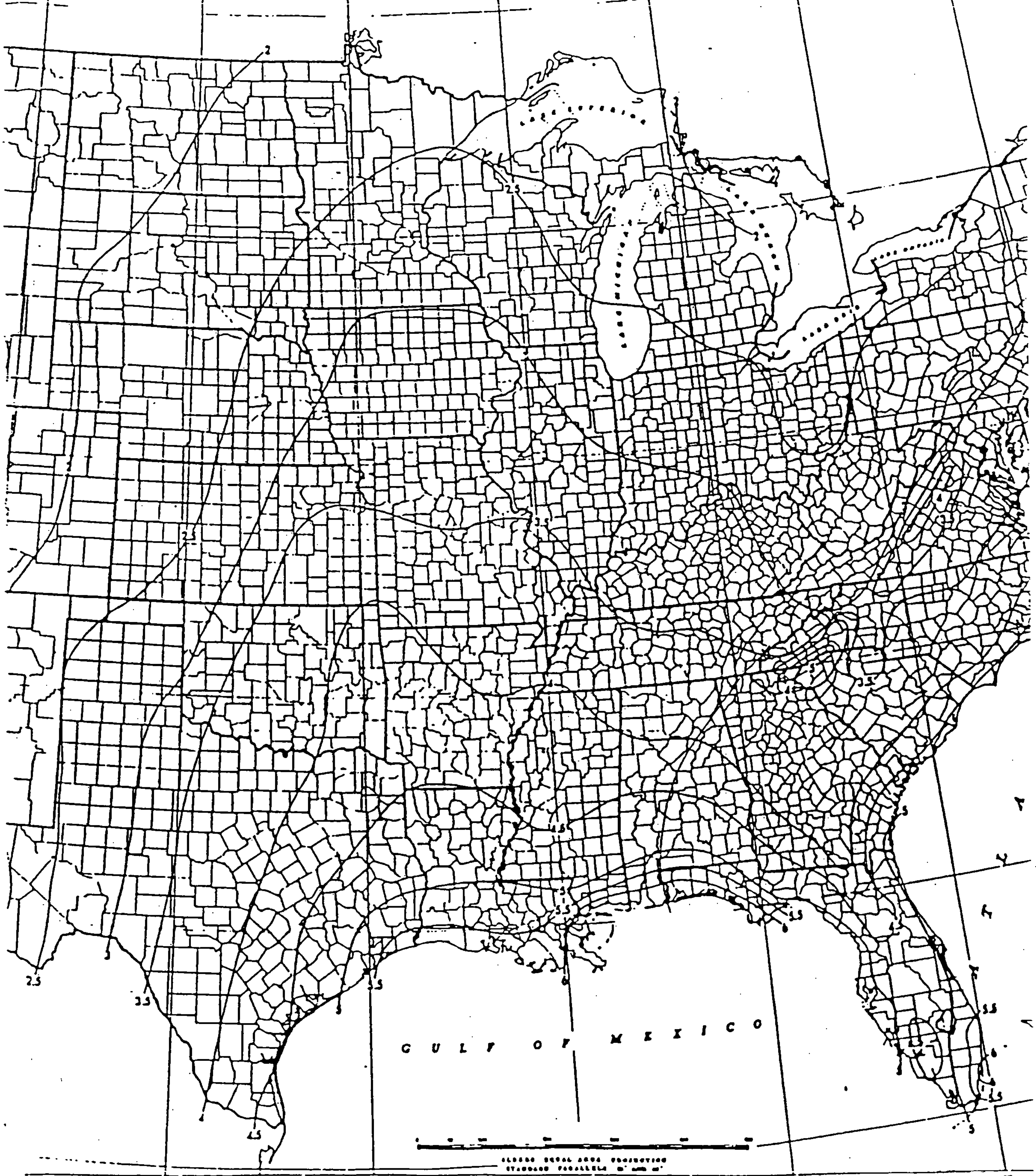
for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

Ref 5

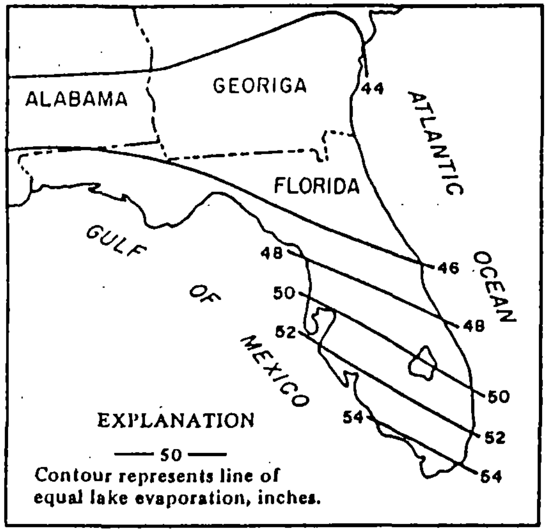
Reference 10

2-YEAR 24-HOUR RAINFALL (INCHES)

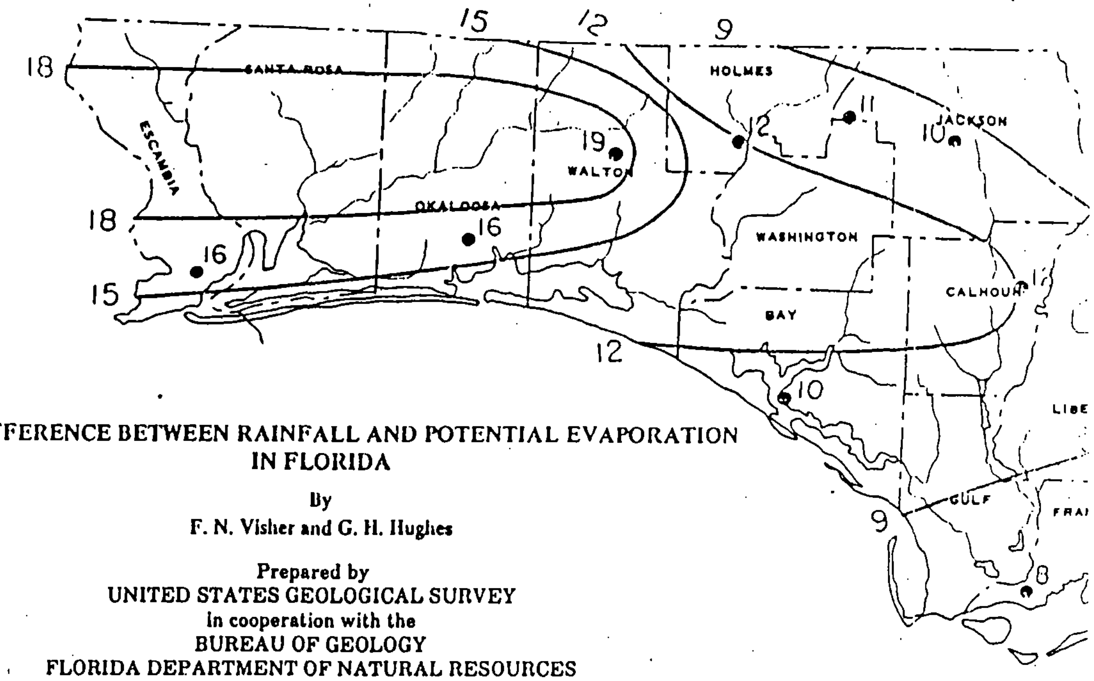


89° 88° 87° 86° 85°

31° 30° 29°



AVERAGE ANNUAL LAKE EVAPORATION



THE DIFFERENCE BETWEEN RAINFALL AND POTENTIAL EVAPORATION IN FLORIDA

By
F. N. Visher and G. H. Hughes

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES
TALLAHASSEE, FLORIDA
1969
SECOND EDITION 1975

Rainfall in Florida is generally abundant, but man presently has little opportunity to control or direct the use of a large part of the total rainfall. Evaporation from land, water and plant surfaces has first call on much of the rainfall. Evaluation of the amount and areal variation of rainfall in excess of all evaporative losses is a necessary factor in appraising the outflow of water from an area. Outflow is the total surface and ground water flow from an area, and is equal to the difference between rainfall on an area and actual evaporation from an area.

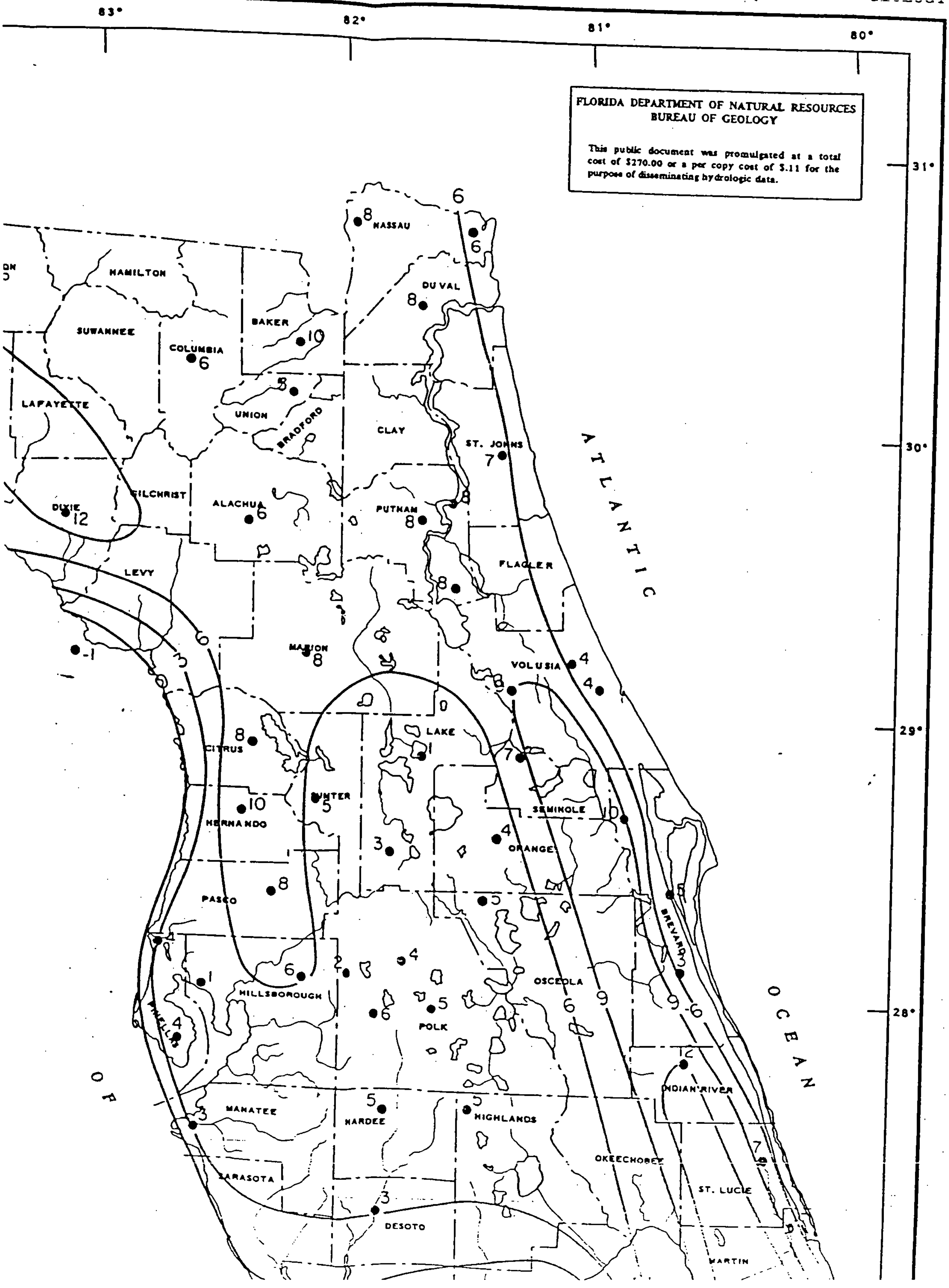
Present technology does not permit accurate determination of evaporation from large areas of diversified soils and vegetative cover where the availability of water may differ and vary both in time and in space. Thus, outflow is not determined directly, but is evaluated by determining the incremental outflow that results from the excess rainfall in the area. Such an approach usually is practicable in areas where the total outflow occurs in well-defined surface channels. In Florida, however, many areas are underlain by permeable limestone aquifers which transcend surficial drainage divides and which transmit large quantities of water underground. Even though part of the water

The values shown by the evaporation map depend on meteorological factors such as solar radiation, wind movement, air temperature, and humidity, all of which are importantly related to lake evaporation. Thus, the values are applicable to individual lakes as long as the lakes are openly exposed to wind movement, a requirement met by most large lakes in Florida. The same requirement may not be met by some small lakes covering only a few acres that may lie at the bottom of deep sinkhole depressions or that may be entirely rimmed by tall and dense vegetation.

Yearly potential evaporation varies only slightly compared to yearly rainfall, which in many areas of Florida ranges from about 50 percent greater than normal to about 50 percent less than normal. Although some of the excess rainfall of wet years may be carried over as soil moisture or stored in lakes or in a shallow water table, much of the excess rainfall flows out of the area and does not remain available for evaporation in subsequent years. Similarly, but in a somewhat opposite sense, the energy represented by potential evaporation that cannot be used because of a lack of water during a dry year is not stored for later use but rather is dissipated. Because the yearly and seasonal

In northeast Florida, the d
evaporation ranges from 6
panhandle area. In the part
entirely or almost entirely in
about 14 inches. Large areas
evaporation losses are almost
other hand, larger areas are n
of surface streams. Much of the
downward to the water table a
without large evaporation losse

Over a large part of central
and potential evaporation is
part of this area, including prin
of Polk County, there are nun
of this area, evaporation a
evaporation potential and ru
difference between the rainf
runoff from the area, as mea
Withlacoochee River, the Little



FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

This public document was promulgated at a total cost of $270.00 or a per copy cost of $.11 for the purpose of disseminating hydrologic data.

Refer Reference 11

Hydrology of the Floridan Aquifer System in Southeast Georgia and Adjacent Parts of Florida and South Carolina

By RICHARD E. KRAUSE *and* ROBERT B. RANDOLPH

REGIONAL AQUIFER-SYSTEM ANALYSIS—FLORIDAN AQUIFER SYSTEM

U. S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1403 – D

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1989

CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

CONVERSION FACTORS

Factors for converting inch-pound units to the International System (SI) of units are given below:

Multiply	*By*	*To obtain*
	Length	
inch (in)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	~~3.785~~	liter (L)
	3.785×10^{-3}	cubic meter (m^3)
	Flow	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	6.309×10^{-5}	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
cubic foot per second (ft^3/s)	2.832×10^{-2}	cubic meter per second (m^3/s)
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Leakance	
gallon per day per cubic foot [$(gal/d)/ft^3$]	0.1337	meter per day per meter [(m/d)/m]
foot per day per foot [(ft/d)/ft] (or in reduced form, day^{-1})	1.000	meter per day per meter [(m/d)/m]
	Gradient	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Drawdown	
foot per year (ft/yr)	0.3048	meter per year (m/yr)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

HYDROLOGY OF THE FLORIDAN AQUIFER SYSTEM IN SOUTHEAST GEORGIA AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA

By Richard E. Krause and Robert B. Randolph

ABSTRACT

The ground-water flow of the Floridan aquifer system under predevelopment (about 1880) and present-day (1980) conditions in southeast Georgia and adjacent parts of Florida and South Carolina was simulated using a three-dimensional finite-difference digital model. The model was used to better define the hydrogeology and ground-water flow system in the Floridan aquifer system in that area.

The Floridan aquifer system, known as the principal artesian aquifer in Georgia, South Carolina, and Alabama, and as the Floridan aquifer in Florida, consists of interbedded clastics and marl in the updip area and massive limestone and dolomite more than 2,000 feet thick in the downdip area. The Floridan aquifer system, primarily of Eocene age, is hydraulically connected in varying degrees but has been divided into the Upper and Lower Floridan aquifers in most of the study area. In southeast Georgia and northeast Florida, the Lower Floridan includes a basal unit herein formally designated the "Fernandina permeable zone." The Floridan, in most of the area, is confined above by clay beds of the Miocene Hawthorn Formation. Low-permeability clastic, evaporitic, or carbonate rocks form the base of the aquifer system.

The Floridan is heterogeneous; transmissivity of the Upper Floridan ranges from nearly zero near the aquifer's updip extent to about 1 million feet squared per day in the cavernous thick carbonate sequence in south Georgia. Areally, the Floridan is traversed by the Gulf Trough, a structurally controlled, clastic-infilled series of grabens, approximately aligned along strike. This feature is an important control on the regional flow system; it impedes flow from the upgradient, primarily clastic part to the downgradient, massive carbonate part of the Floridan.

Simulation results indicate that a total of about 900 million gallons per day (1,400 cubic feet per second) of water flowed through the aquifer system prior to development. About two-thirds of this flow was in the area upgradient from the Gulf Trough. This flow consisted of recharge in areas between streams, lateral movement downgradient, and discharge to the major rivers. The flow system in most of the area downgradient from the Gulf Trough was characterized by slow lateral movement resulting from low diffuse recharge and discharge. Throughout the study area, almost all circulation was within the Upper Floridan.

Pumpage from the aquifer system, totaling about 625 million gallons per day (970 cubic feet per second) in 1980 and concentrated primarily in the areas downgradient from the Gulf Trough, changed the flow system markedly. The flow system was nearly unchanged upgradient from the Gulf Trough, where less than 5 percent of the pumpage occurred. Downgradient from the trough, large ground-water withdrawals concentrated along the coast, primarily from the Upper Floridan, caused significant head declines. These head declines caused lateral and vertical gradient changes and reversals, increased circulation in, and upward leakage from, the Lower Floridan and the Fernandina permeable zone, a local degradation in water quality, and land subsidence. Although not tapped by producing wells, the Fernandina permeable zone provided about 180 million gallons per day (280 cubic feet per second) of water to the coastal pumpage through solution-enlarged faults breaching the confining beds. The quality of the water in the Fernandina permeable zone ranged from fresh to brine, locally contaminating the Upper Floridan, most notably in Brunswick, Georgia. Model-simulated flow through the Floridan aquifer system under present-day (1980) conditions totaled about 1,350 million gallons per day (2,100 cubic feet per second).

Although heavily developed along the coast, the Floridan could withstand some additional development, especially inland, as indicated by simulations involving future hypothetical pumping schemes. The area around Waycross, Georgia, could probably undergo additional development of more than 26 million gallons per day (about 40 cubic feet per second), but in some places along the coast, where heavy withdrawals have already posed water-quality problems, additional development probably could not occur without detrimental effects to the system.

INTRODUCTION

The Floridan aquifer system, known as the principal artesian aquifer in Georgia, Alabama, and South Carolina and as the Floridan aquifer in Florida, is the major source of water in the area of its occurrence, except where it contains saline water. About 625 Mgal/d (970 ft^3/s) of water was withdrawn from the aquifer in 1980 for industrial, municipal, agricultural, and other uses in the eastern half of the Coastal Plain of Georgia, northeast Florida, and the southern part of South Carolina. Problems that have developed because of this

heavy withdrawal are (1) decline in water levels, chiefly around pumping centers, but areawide as well, (2) highly mineralized water induced into the aquifer from underlying strata, (3) seawater moving toward pumping centers from offshore, and (4) land subsidence.

In 1978, the U.S. Geological Survey began a study of the Floridan aquifer system on a regional scale under its Regional Aquifer-System Analysis (RASA) program. The RASA program represents a systematic effort to study a number of regional aquifers which together cover much of the country and provide a significant part of the Nation's water supply. (See fig. 1 in chapter A of this Professional Paper series (Johnston and Bush, in press) for the location of these regional aquifers.) The overall objectives of the Floridan aquifer-system study include (1) a complete description of the hydrogeologic framework and geochemistry of the entire aquifer system, (2) an analysis of the ground-water flow through the aquifer system, (3) an assessment of the effects of large withdrawals of ground water on the aquifer, and (4) an appraisal of water-management alternatives. The study is regional in scope, and the aquifer system is defined in its entirety, without regard to political subdivisions.

Components of the Floridan aquifer-system analysis were divided on the basis of discipline, as well as areally. Areal subdivisions were based on the similarity of hydrologic features and problems and on the location of natural hydrologic boundaries within the aquifer system (fig. 1). Results of the study are being published as separate chapters in this Professional Paper series as follows:

A. Summary of the hydrology of the Floridan aquifer system
B. Hydrogeologic framework of the Floridan aquifer system
C. Regional hydrology and ground-water development of the Floridan aquifer system
D–H. Hydrology of the Floridan aquifer system:
- D. In southeast Georgia and adjacent parts of Florida and South Carolina (this report)
- E. In east-central Florida
- F. In west-central Florida
- G. In south Florida
- H. In southwest Georgia, northwest Florida, and extreme south Alabama

I. Geochemistry of the Floridan aquifer system.

Chapter A summarizes the hydrogeologic framework, hydraulic characteristics, and geochemistry of the aquifer system.

Chapter B describes the geologic framework and hydrogeologic characteristics of the aquifer system. Maps, sections, and fence diagrams show the relations of lithofacies, structure, thickness, and stratigraphy to aquifer and confining-unit geometry.

Chapter C presents a description of the regional flow system based on digital simulation and discusses ground-water development on a regional scale.

Chapters D–H present descriptions of the ground-water hydrology of the subregions emphasizing local hydrologic features and development.

Chapter I describes the natural geochemistry of the aquifer system. Maps, sections, phase diagrams, and tables are used to explain the occurrence of the hydrochemical facies, the relation between natural changes in water chemistry and the flow system, and geochemical changes induced by pumping and land development.

HISTORICAL TERMINOLOGY OF THE FLORIDAN AQUIFER SYSTEM

The existence of a regional flow system in what is herein called the Floridan aquifer system was first described in some detail in peninsular Florida by Stringfield (1936, p. 132, pl. 12). Warren (1944, p. 17) described the extension of this flow system in southeastern Georgia and applied the term "principal artesian aquifer" to the carbonate units involved (table 1). Stringfield (1966, p. 95) used the term "principal artesian aquifer" to describe the permeable carbonate rocks from the lower part of the Hawthorn Formation through the Oldsmar Limestone in Georgia and South Carolina, as well as in Florida and Alabama. The term "principal artesian aquifer" as defined by Stringfield has been used in Georgia and South Carolina.

Parker (in Parker and others, 1955, p. 188, 189) described the limestone units from the basal part of the Hawthorn Formation through middle Eocene (Lake City) limestone and named that sequence the "Floridan aquifer." The term "Floridan aquifer" is entrenched in the Florida ground-water literature and is also widely used in national and international publications.

Cederstrom and others (1979, p. 8, 14) referred to the aquifer as the "Tertiary limestone aquifer." Their designation of the aquifer includes rocks, primarily carbonates, of the Tampa Limestone through the Oldsmar Limestone.

During the regional study of the Floridan aquifer system, Miller used the term "Tertiary limestone aquifer system," which combined the age of the rocks and their general lithology, as the name of the aquifer system (Miller, 1982a, b, c, d, e). By the end of the study, the term "Floridan aquifer system" was formally applied to the aquifer system (Miller, 1985). The term "Floridan aquifer system" is uniformly used in all chapters of this Professional Paper series and is proposed

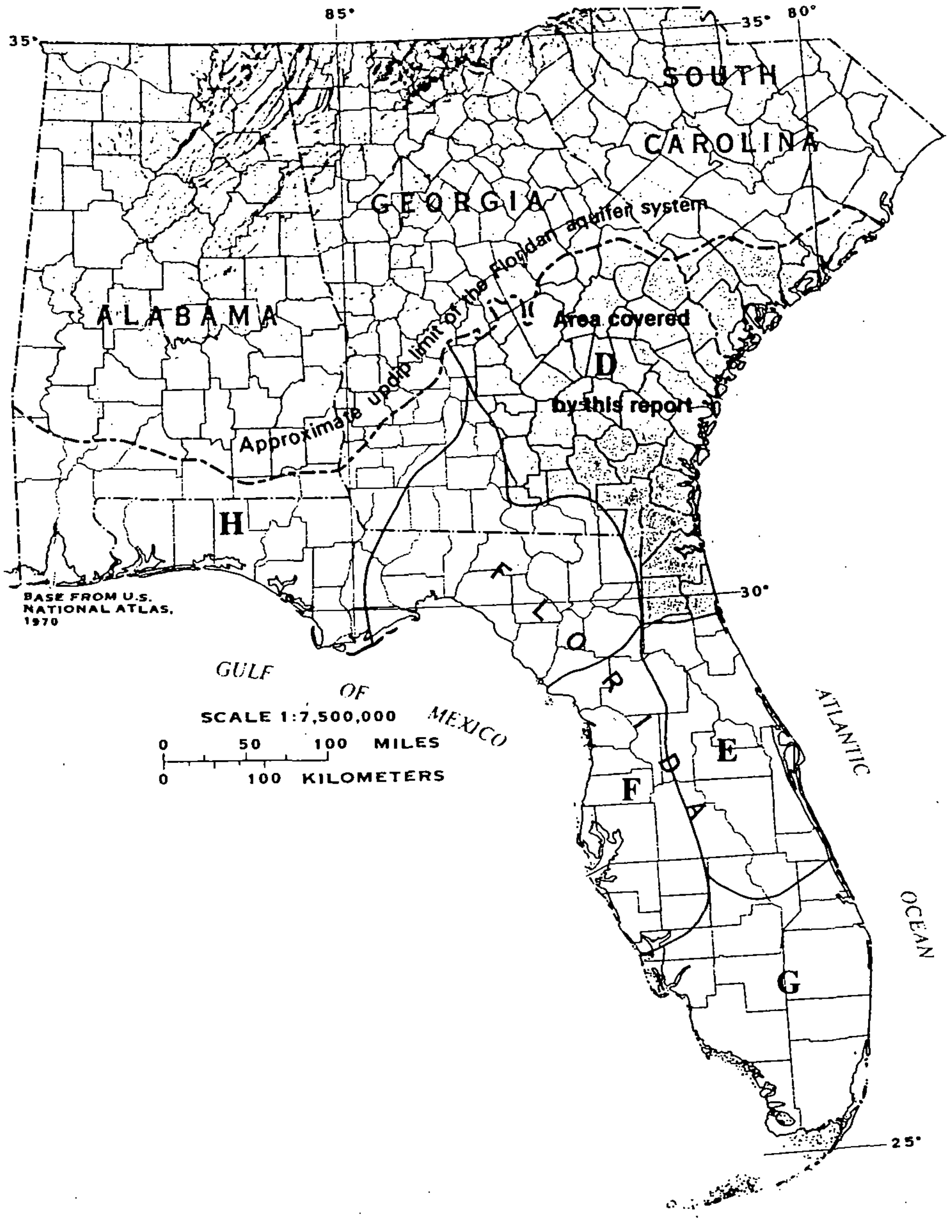


FIGURE 1.—Location of Floridan aquifer system study area, subregional project areas, and chapter designations in Professional Paper 1403.

for use in further investigations of the aquifer system. Because distinct, regionally mappable hydrogeologic units occur within the carbonate sequence, the term "aquifer system" is preferred to "aquifer." Use of "system" follows Poland and others (1972, p. 2), who stated that an aquifer system "* * * comprises two or more permeable beds separated at least locally by [confining beds] that impede ground-water movement but do not greatly affect the regional hydraulic continuity of the system." This definition applies to the Floridan aquifer system throughout most of its area of occurrence. (See table 1 for a summary of historical terminology and stratigraphy applied to the Floridan aquifer system.)

PURPOSE AND SCOPE

The overall purpose of this study was to describe the Floridan aquifer system in southeast Georgia and adjacent parts of Florida and South Carolina. Specifically, the objectives of the study were to (1) describe and

TABLE 1.—*Summary of historical terminology applied to the Floridan aquifer system*

Series		Formation[1]	Warren (1944)	Parker and others (1955)	Stringfield (1966)	Cederstrom and others (1979)	Miller (1982b, 1982d)	This report[2]
Miocene		Hawthorn Formation		Where permeable				
		Tampa Limestone		Floridan aquifer	Principal artesian aquifer	Where present and permeable		
Oligocene		Suwannee Limestone	Principal artesian aquifer			Tertiary limestone aquifer	Tertiary limestone aquifer system	Floridan aquifer system[3]
Eocene	Upper	Ocala Limestone						
	Middle	Avon Park Formation[2,4]						
	Lower	Oldsmar Formation[2,5]						
Paleocene		Cedar Keys Formation[2,6]						

[1] Principal, most areally extensive formations representative of the downdip area.
[2] Based on Miller (1985), Professional Paper 1403-B.
[3] Tampa Limestone absent in the study area; rocks of Late Cretaceous age form the lowermost part of the aquifer system locally in the Brunswick, Ga., area.
[4] Formerly Avon Park Limestone and Lake City Limestone
[5] Formerly Oldsmar Limestone.
[6] Formerly Cedar Keys Limestone.

delineate the hydrogeologic framework of the aquifer system, (2) describe the flow system prior to development, (3) describe the present-day (1980) flow system and the changes that occurred as a result of development, (4) determine the potential for additional development, and (5) describe the quality of water in the aquifer system and its relation to present-day stresses.

This report describes the results of the study and relates to the other chapters of this Professional Paper series as stated below.

The hydrogeologic framework of the aquifer system as it relates to the ground-water-flow system in the study area is described and delineated in this report. A detailed description of the hydrogeologic framework on a regional scale is presented by Miller (1985) in chapter B of this Professional Paper series. The hydrogeologic framework described herein is largely that of Miller's chapter B; however, some differences exist because of the difference between the regional and the local scales. The local hydrogeologic units are subdivisions of larger units that make up the regional hydrogeologic framework.

The predevelopment and present-day flow systems of the Floridan aquifer system in southeast Georgia and adjacent parts of Florida and South Carolina are described quantitatively in this report. In chapter C of this Professional Paper series, Bush and Johnston (in press) describe the flow system on a less detailed, regional scale. A one-to-one correlation of the quantitative results described in this report and in Bush and Johnston's report cannot be made because of the difference in simulation scale. However, the simulations described in both reports are based on the same set of data.

Determinations of the potential for additional ground-water development from the Floridan aquifer system in the study area are included in this report. Computer simulations, as well as existing information on the hydrology and water quality, provided the basis for the analysis. Bush and Johnston (in press) also include a section on development potential, but it is of lesser detail and is more general in scope.

Only a general description of the geochemistry of the Floridan aquifer system in the study area is included in this report. The quality of the water in areas where it is found to be locally of poor quality is described in greater detail. In these areas, the poor-water-quality features are related to the flow system as it existed prior to development, and as it exists as a result of ground-water development. A more detailed description of the geochemistry of the entire aquifer system is discussed in chapter I of this Professional Paper series (Sprinkle, in press). However, water-quality anomalies or local problems are discussed only in a general way in chapter I.

APPROACH AND METHODS

The hydrogeologic framework of the Floridan aquifer system was determined chiefly by Miller (1985), who delineated the aquifer system on the basis of lithologic, paleontologic, and hydrologic data determined from selected wells. These data were correlated with geophysical well-logs and were extrapolated throughout the study area.

Most of the hydrologic data used in this study were available from previous investigations and ground-water monitoring programs. Sources of the data, some of which dated back to the late 1800's, were the published literature, files containing unpublished data in the form of tables, maps, graphs, and logs, and the more recent computer data bases.

The types of data assembled and used in the analysis and simulation of the flow system included the following: (1) precipitation, streamflow, evapotranspiration (derived from rainfall, pan-evaporation, and temperature data), used for determining recharge and discharge rates; (2) aquifer characteristics, including thickness, specific capacity, hydraulic conductivity, and transmissivity; (3) hydraulic head; (4) confining-unit characteristics, including thickness, vertical hydraulic conductivity, and leakage coefficients; and (5) water use.

Most of the water-quality data used in the description of the geochemistry of, and quality of water from, the aquifer system were collected and published as part of previous investigations and water-quality monitoring programs. Interpretations of water quality were focused primarily on local anomalies, such as concentration of chloride in the areas of saltwater encroachment.

The gathering of new field data was limited to selected areas and activities to fill specific data voids, as follows:

1. Two wells penetrating the entire Floridan aquifer system were drilled near Waycross, Ga. Geologic, geophysical, hydrologic, and water-quality data were collected from coring, logging, packer testing, aquifer testing, and water sampling. Results are reported by Matthews and Krause (1984).
2. An offshore oil-test well abandoned in 1979 was used for data collection, including drill-stem testing. Geologic, geophysical, hydrologic, and water-quality data were collected and analyzed, and were reported by Johnston and others (1982).
3. In May 1980, synoptic water-level measurements were made in approximately 500 wells tapping the Floridan aquifer system in the study area. The resulting potentiometric surface provided information on the present-day (1980) flow system and was used for model calibration. The map and the related information were reported by Johnston and others (1981).
4. Geophysical logging was done in selected wells where data were lacking to provide better definition of the hydrogeologic framework.

The principal method of analysis of the Floridan aquifer system was computer simulation. Computer simulation was used to (1) identify the types of data that are needed to understand the flow system, and to indicate what data were lacking, (2) provide a working hypothesis for testing and evaluating various concepts of the flow system, and (3) provide a tool that can be used to evaluate alternative methods of resource management and to estimate the development potential of the aquifer system.

The computer model used in this analysis is a quasi-three-dimensional, finite-difference code that simulates lateral flow within aquifers and leakage vertically across confining units. All components of the flow system within the Floridan aquifer system, as well as hydrologic units that are adjacent to it and that affect it hydrologically, are part of the simulation.

LOCATION AND EXTENT OF STUDY AREA

The hydrogeologic investigation covers an area of about 30,000 mi^2 in southeast Georgia and adjacent parts of Florida and South Carolina, of which 10,000 mi^2 is offshore (fig. 1).

The extent of the study area is based on natural hydrologic boundaries. The western and southern boundaries were delineated on the basis of ground-water divides. The northern boundary is the outcrop area and updip limit of the aquifer system. The eastern boundary is the easternmost limit of the aquifer system in South Carolina or the freshwater–saltwater interface offshore in Georgia and part of South Carolina.

PREVIOUS INVESTIGATIONS

The hydrogeology of the Floridan aquifer system in southeast Georgia and in parts of Florida and South Carolina has been investigated extensively in the areas of greatest development. However, these studies are restricted almost entirely to a narrow band between the coastal cities of Savannah, Ga., and Jacksonville, Fla., which represents less than 15 percent of the area included in this study. Among the more recent and comprehensive hydrogeologic investigations in this coastal area are those by Hayes (1979) and Spigner and Ransom (1979) in the Low Country (southern part) of South Carolina, Counts and Donsky (1963) in the area of Savannah, Ga., Dyar, Tasker, and Wait (1972) and Krause (1972) in parts of Liberty and McIntosh Counties, Ga., Wait and Gregg (1973) and Gregg and Zimmerman (1974) in the area of Brunswick, Ga., and Bermes, Leve,

and Tarver (1963), Leve (1966) and Snell and Anderson (1970) in the northeast Florida area. Paull and Dillon (1979) provide a description of the geology and hydrogeology of the offshore area, the Florida–Hatteras Shelf and Slope, and the Inner Blake Plateau.

Inland from the coastal area, almost no hydrogeologic investigations have been conducted and data are lacking. One exception was an investigation by Krause (1979) of the hydrogeology of the area of Valdosta, Ga., on the western limit of this study.

Callahan (1964), using existing data, included most of the study area in a report on the Coastal Plain aquifers in Georgia and parts of northeast Florida and southern South Carolina. Stringfield (1966) is the most comprehensive reference on the water from Tertiary limestone in the Southeastern States.

Only in two areas has the ground-water-flow system been studied by using computer simulations. The studies were in Georgia, in the areas of Brunswick (Krause and Counts, 1975) and Savannah (Counts and Krause, 1976; Randolph and Krause, 1984). The simulation models, although only two-dimensional in scope, serve as management tools for evaluating declines in the water level and deterioration of water quality due to heavy pumping.

The regional aquifer-system study of the Floridan aquifer system has generated several reports in addition to those in this Professional Paper series. These reports, all covering the Floridan aquifer system on a regional scale, describe the hydrogeologic framework of the aquifer system (Miller, 1982a, b, c, d, e); the geochemistry and ground-water quality (Sprinkle, 1982a, b, c, d); the estimated potentiometric surface prior to development (Johnston and others, 1980); and the potentiometric surface for present-day (May 1980) conditions (Johnston and others, 1981).

Results of test drilling and aquifer testing conducted during this investigation have been reported. Included are (1) results of hydrologic testing in an abandoned oil exploratory hole on the Atlantic Outer Continental Shelf (Johnston and others, 1982), (2) geologic and hydrologic data from a test-monitor well at Fernandina Beach, Fla. (Brown, 1980), (3) geologic and hydrologic results of test drilling and aquifer testing near Waycross, Ga. (Matthews and Krause, 1984), and (4) geologic and hydrologic data gathered from test drilling at Jacksonville Beach, Fla. (Brown and others, 1984).

The predevelopment flow system in the study area was described by Krause (1982) as part of this study. The report documents the initial phase of this study: model design, calibration, and results of computer simulation of the aquifer flow system prior to development. Because the report was preliminary in scope, conceptualization of the aquifer system was more general than that reported herein. In effect, the preliminary report describes a working conceptual model and consequent simulation of the predevelopment flow system in the Floridan. However, simulation of the present-day (1980) flow system under stressed conditions brought about a somewhat different conceptual model of that flow system.

GEOGRAPHIC AND TOPOGRAPHIC SETTING

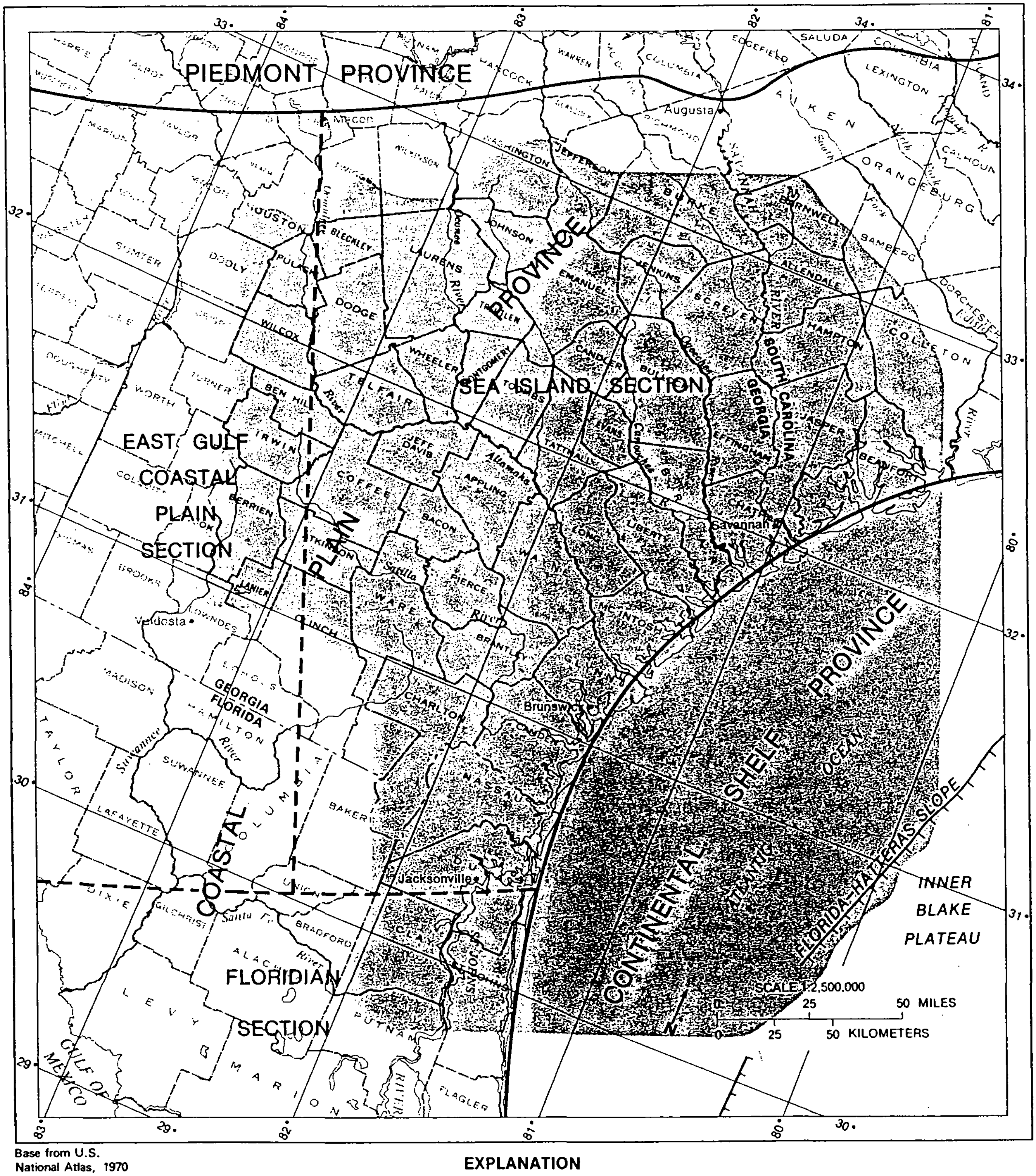
The study area lies entirely within the Coastal Plain and Continental Shelf provinces of the Atlantic Plain (Fenneman, 1938, pl. 3). The onshore Coastal Plain province accounts for about 20,000 mi^2 of the study area and the offshore Continental Shelf province, about 10,000 mi^2. Of the Coastal Plain province, about 75 percent of the area is within the Sea Island section, 16 percent within the East Gulf Coastal Plain section, and 9 percent within the Floridan section (fig. 2).

The topographic divisions shown in figure 3 are chiefly those of Cooke (in LaForge and others, 1925, p. 17, for Georgia; Cooke, 1936, p. 3, for South Carolina; and Cooke, 1939, p. 14, for Florida). Stringfield (1966, fig. 2) modified the divisions somewhat to conform along State lines.

The Coastal Lowlands range in altitude from sea level to about 100 ft. The region typically consists of barrier islands, marshes, level plains, and a series of five terraces resulting from the most recent advances and retreats of the sea during the late Pleistocene, which left shorelines and sea floors along the Coastal Lowlands.

The Central Highlands of Florida include all of north-central Florida inland of the Coastal Lowlands and range in altitude from about 40 to 250 ft in the study area. The Central Highlands area includes lakes, swampy plains, terraces, ridges, and hills. The central part of the Central Highlands is marked by karst topography—characterized by numerous sinks, sinkhole lakes, sinking streams, and springs—that extends into the Valdosta area of south Georgia. The karst topography in this area is a result of uplifting of the carbonate rocks during post-Oligocene time which locally exposed the rocks and facilitated erosion of the overburden (Stringfield, 1966, p. 73). This part of the study area, because of its karst features, is one of the most hydrologically dynamic areas, having large quantities of recharge through swallow holes, sinkholes, and sinkhole lakes, and discharge from springs.

The Coastal Terraces of Georgia and South Carolina range in altitude from about 100 to 270 ft. The area's topography is chiefly an inland continuation of the terraces deposited along the Coastal Lowlands and is represented by similar shorelines and sea bottoms left by early Pleistocene advances and retreats of the sea.



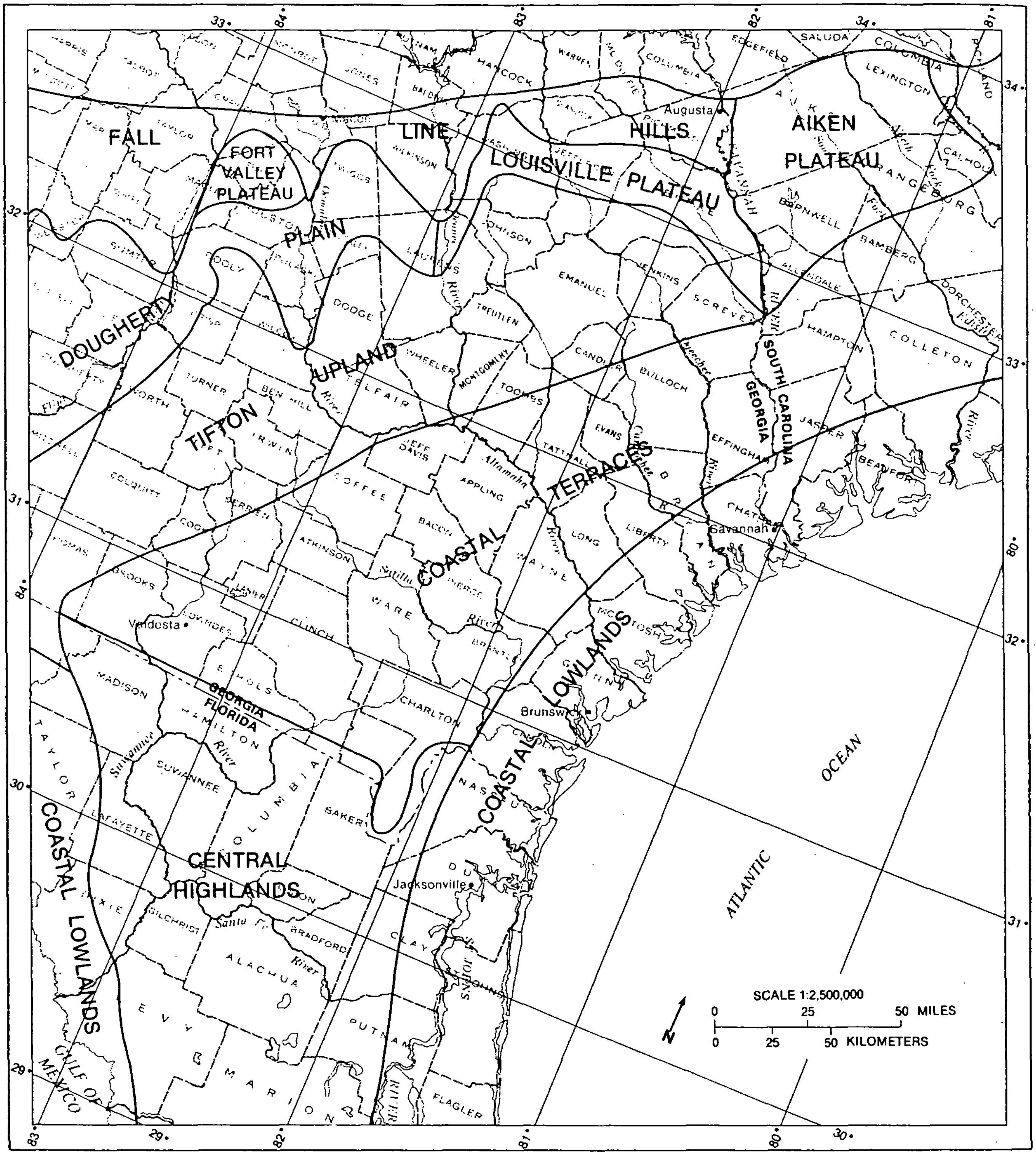
EXPLANATION

Province boundary

Section boundary

Study area

FIGURE 2.—Location of study area and physiographic subdivisions. From Fenneman (1938).



Base from U.S.
National Atlas, 1970

FIGURE 3.—Generalized topographic divisions of the Coastal Plain province. From LaForge and others (1925), Cooke (1936; 1939), and Stringfield (1966).

The Tifton Upland ranges in altitude from about 120 to 400 ft in the study area and is characterized by rolling hills and both gentle and deeply incised valleys. The Hawthorn Formation of Miocene age (table 1) underlies the Tifton Upland and extends downdip toward the coast, becoming more deeply buried under the Coastal Terraces. The upland is terminated to the northwest by a scarp and to the southeast by the Coastal Terraces. The Coastal Terraces boundary of the Tifton Upland is the approximate downdip edge of the Gulf Trough, a series of clastic-filled basins formed by high-angle faults (D.C. Prowell, U.S. Geological Survey, written commun., March 1982; Miller, 1985). The trough is narrow, generally less than 5 mi wide but as much as 10 mi wide in central Georgia and near the Florida–Georgia State line. The trough has a pronounced effect on the hydrology of the aquifer system, as ground-water flow is impeded by the fine clastic material in the trough, and on water quality, as mineralized water is associated with evaporites downgradient from the trough.

The Dougherty Plain ranges in altitude from about 200 to about 600 ft in the study area. The Dougherty Plain is typical of a karst topography, especially in the southwestern part of Georgia where limestone is covered by only a thin residuum. The northwestern part of the plain is characterized by subtle hills and valleys. Here the Hawthorn Formation is missing and the aquifer grades into sands.

The Louisville Plateau and Fort Valley Plateau are similar to the northeastern part of the Dougherty Plain. The plateaus range in altitude from about 300 to 600 ft and are characterized by broad, flat uplands. The area of the Louisville Plateau is roughly the same as the areal extent of sand and calcareous sand (Barnwell Formation) that is equivalent in age to the Upper Floridan aquifer. The Fort Valley Plateau is also underlain by this sand.

The Aiken Plateau is similar to the Louisville Plateau, having about the same altitude range and being underlain by similar material. Undrained depressions and Carolina Bays are common in the Aiken and Louisville Plateaus.

The Fall Line Hills area ranges in altitude from about 300 to 800 ft and is characterized by rolling hills and valleys. The area corresponds roughly with the outcrop area of Cretaceous material that extends from the Piedmont province at the Fall Line to the plains and plateaus coastward.

GENERAL HYDROLOGY

PRECIPITATION

Average annual precipitation based on the records for 1941–70 ranges from less than 44 in/yr south of Augusta, Ga., to more than 58 in/yr in a small area west of Jacksonville, Fla. (fig. 4). Each area of extreme range is represented by only one climatological station. In most of the study area, the average annual precipitation ranges from 46 to 56 in/yr. Precipitation is generally lowest in the east-central part of the Coastal Plain of Georgia and along the South Carolina coast and greatest in northern Florida.

Rainfall is unevenly distributed throughout the year. Within the study area, maximum rainfall, mainly from thunderstorms, occurs during the summer months of July and August in most of Georgia and in South Carolina. Maximum rainfall occurs in June, July, and August in south Georgia, and in July, August, and September in northeast Florida. Minimum rainfall occurs during October and November over most of the area and extends through December in south Georgia and northeast Florida, and through January farther south in Florida. Seasonal variation is greater in the coastal area than inland.

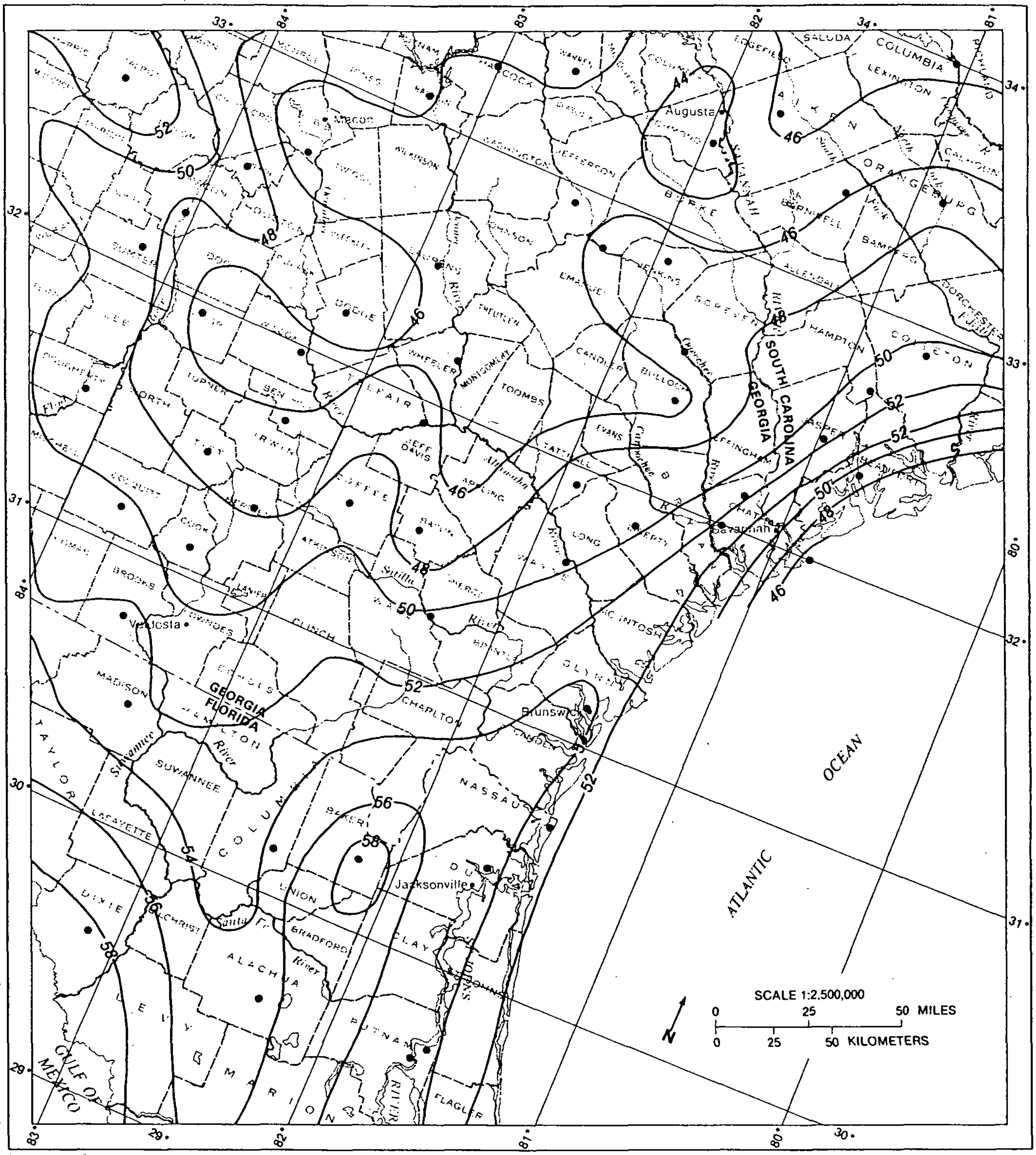
Rainfall as a source of recharge to aquifers is most important during the nongrowing season, when evapotranspiration is lowest. Generally, October through March constitutes the nongrowing season in the study area. During this period, average precipitation ranges from about 15 in/yr along the coast to almost 25 in/yr immediately below the Fall Line.

RUNOFF

Average annual runoff, based primarily on records for the period 1941–70, ranges from about 10 to 15 in/yr in most of the study area (fig. 5). Runoff is generally lowest along the coast and highest immediately below the Fall Line, corresponding to a similar distribution of precipitation.

Runoff is anomalously high in the Suwannee River basin, where average annual runoff for the period of record was greater than 35 in/yr. Rainfall is also high in this area (fig. 4), but the primary cause of the high runoff is interbasin transfer of water. In this area, water derived from rainfall in adjacent basins moves through the Floridan aquifer system and discharges as springs or seeps into the downgradient part of the Suwannee River basin. Conversely, the upgradient part of this basin loses significant quantities of water to sinking streams, thereby anomalously reducing runoff. Therefore, in the karst areas of north-central Florida and extreme south-central Georgia, basin runoff is not a simple function of the rainfall less evapotranspiration and infiltration, but also is related to karst topography.

Lines of equal runoff in figure 5 are drawn on the basis of average annual runoff at the centroid of the drainage area above the corresponding stream gages. Ad-



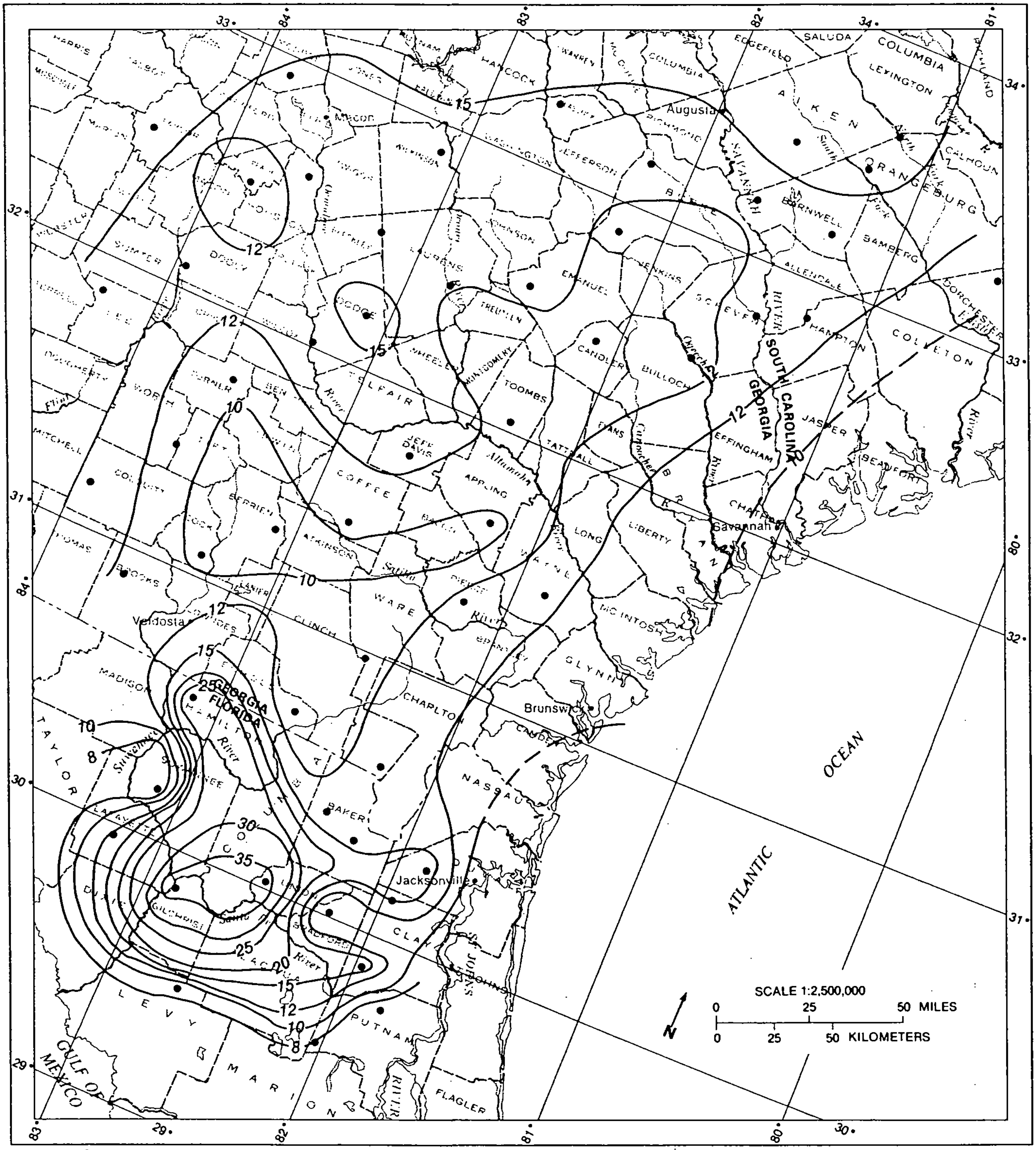
Base from U.S. National Atlas, 1970

EXPLANATION

—52— **Line of equal precipitation**—Interval 2 inches

● **Data point**

FIGURE 4.—Average annual precipitation, 1941–70.



Base from U.S. National Atlas, 1970

EXPLANATION

—*10*— **Line of equal runoff**— Interval 2 inches below 12, 3 inches to 15, and 5 inches above 15. Dashed where approximately located

• **Data point**

FIGURE 5.—Average annual runoff, 1941–70.

justments were made to discharge at gages where diversions, regulations, or consumptive uses were significant. Data were omitted for sites where satisfactory adjustments could not be made. Data for the period 1941–70 were used except for a few sites in South Carolina and Florida, where the only data available were for periods of record: from the forties or early fifties through 1978. Comparison of runoff at several nearby sites for all periods indicated an acceptable correlation. The period 1941–70, rather than the period 1951–80 (both conforming to the 30-year climatological summary period used by the U.S. National Weather Service), was used because more stream-discharge data from gaging stations were available in the earlier period, as several stations were discontinued between 1970 and 1980.

The average annual runoff for Florida shown in figure 5 may differ from that delineated for Florida by Hughes (1978) for several reasons: (1) the method of determining runoff herein, and depicting it with lines of equal runoff, is unlike the method used by Hughes, who merely showed ranges of runoff within major basin boundaries, and (2) data coverage for the method used herein was considerably greater; data from several subbasins, each having a unique runoff, were included herein, but were averaged and lumped into the larger hydrologic units of Hughes.

EVAPOTRANSPIRATION

Evapotranspiration ranges from about 30 to 40 in/yr over the study area (fig. 6). Areal distribution of evapotranspiration rates indicates that evapotranspiration increases from north to south and from inland toward the coast. An exception occurs in southeast Georgia, where the Okefenokee Swamp accounts for the highest rate of evapotranspiration in the State.

Evapotranspiration rates used to construct figure 6 were chiefly those determined by Bush (1982), who used the values to make initial estimates of recharge and discharge rates for the regional flow model. The lines of equal evapotranspiration rates shown in figure 6 were based on 25 data stations located at the centroids of areas that were subdivided on the basis of drainage area and Thiessen polygons of rainfall distribution. Bush (1982) estimated total evapotranspiration rates within each basin from weighted averages of evaporation rates from open-water areas, such as swamps and marshes, and evapotranspiration rates from land areas. He estimated open-water evaporation rates from a map of average annual lake evaporation for the period 1946–55 (Kohler and others, 1959, pl. 2). Evaporation rates from swamp and marsh areas were assumed to be 90 percent of the open-water rate (Bush, 1982).

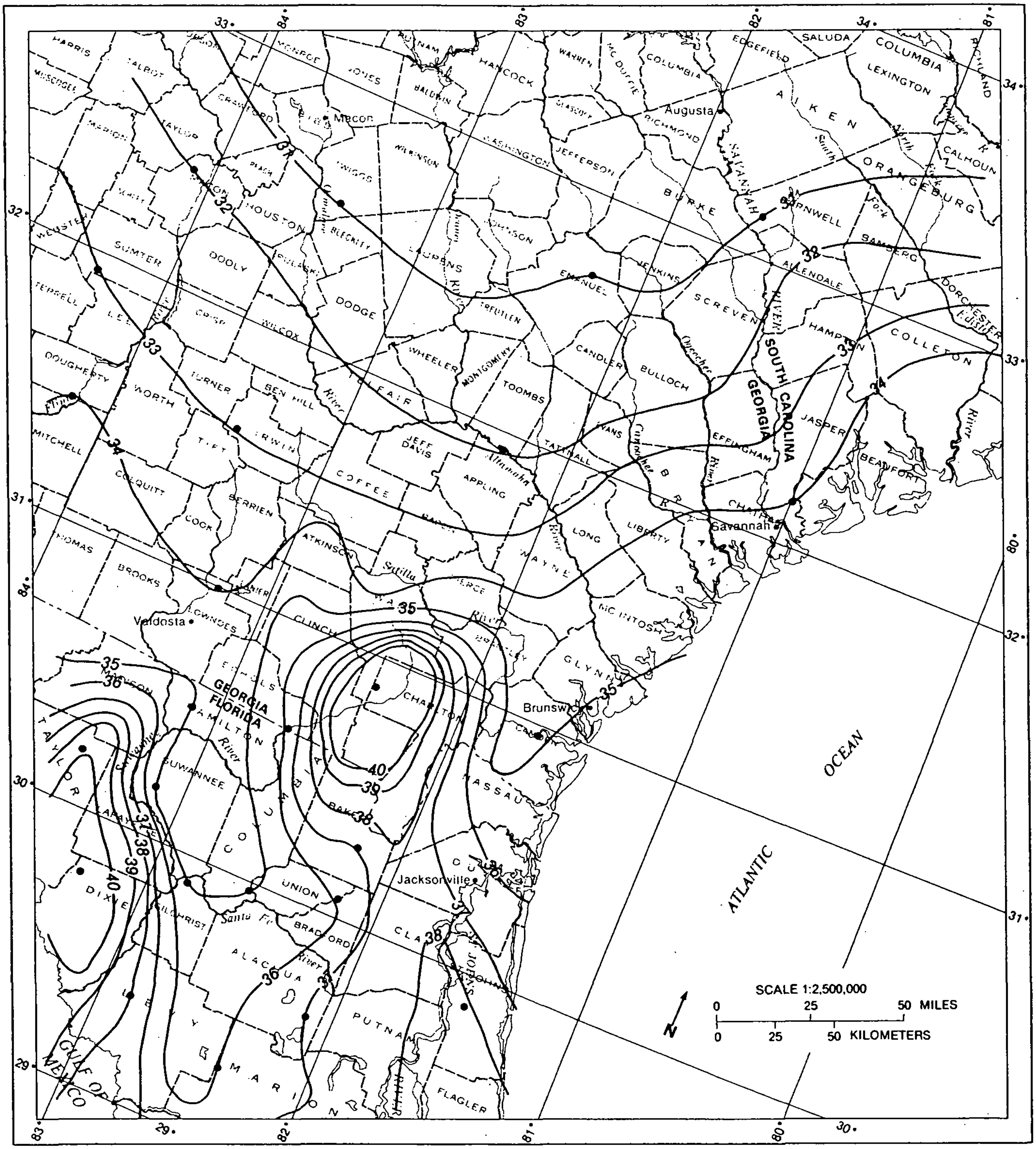
Bush (1982) estimated rates of evapotranspiration from land areas by using a method developed by Holdridge (1967) and later described and used in Florida by Dohrenwend (1977, p. 185). The method uses Holdridge's (1967) "life-zone" bioclimatic classification system, based on latitudinal and altitudinal regions, humidity provinces, soil and vegetative types, and precipitation. The important variable in the method is biotemperature, defined by Holdridge (1967) as the sum of hourly temperatures between 0° and 30°C divided by the number of hours in the year. For a complete discussion of the methodology, see Bush (1982).

HYDROGEOLOGIC SETTING

In general, the Floridan aquifer system is made up of consolidated marine and marginal marine limestone and dolomite and lesser amounts of evaporites, clay, sand, and marl (table 2, in pocket). In the study area, the aquifer system consists of several formations that range in age from early Eocene to Oligocene (table 2). Principal units making up the system are the Oldsmar and Avon Park Formations and the Ocala, Santee, and Suwannee Limestones. Locally, in the Brunswick, Ga., area, rocks of Paleocene age (the Cedar Keys Formation) and the Lawson Limestone of Late Cretaceous age are also part of the aquifer system. In the northern part of the study area, updip clastic facies of the carbonates, although not considered by Miller (1985) to be part of the Floridan aquifer system, are hydraulically connected with it and are thus part of its regional flow system. The aquifer system forms a nearly vertically continuous carbonate sequence that is hydraulically connected in varying degrees. Zones of low permeability and areal continuity exist within the Floridan throughout most of the area and separate the aquifer system into two permeable, water-bearing zones, the Upper Floridan aquifer and the Lower Floridan aquifer, and locally into a third zone, the Fernandina permeable zone, which is part of the Lower Floridan aquifer. The Floridan is confined below by low-permeablity beds of clastic or evaporitic material, and in most of the area is confined above by clayey strata primarily of Miocene age (table 2).

HYDROGEOLOGIC FRAMEWORK OF THE FLORIDAN AQUIFER SYSTEM

The hydrogeologic framework of the Floridan aquifer system in southeast Georgia and parts of Florida and South Carolina described in this report chiefly follows the regional definition of the aquifer system described by Miller (1982a, b, c, d, e; 1985, chapter B of this Professional Paper series). Miller's framework of the aquifer system is restricted to the predominantly carbonate sequence. However, the hydrogeologic framework described herein also includes updip, largely clastic beds



Base from U.S. National Atlas, 1970

EXPLANATION

—37— **Line of equal evapotranspiration**—Interval 1 inch

• **Data point**

FIGURE 6.—Average annual evapotranspiration. Adapted from Bush (1982).

that are chronostratigraphic equivalents of the carbonate sequence and can be shown by simulation to be part of the Floridan's flow system.

The Floridan aquifer system thickens from a featheredge in the northern outcrop area to more than 2,000 ft downdip in coastal Georgia and to more than 2,600 ft locally in the area of Brunswick, Ga. (pl. 1). The system includes all strata that lie between the top of the uppermost continuous high-permeability carbonate sequence (top of the Floridan) and the top of highly clastic or evaporitic rocks having low permeability (base of the Floridan).

Plate 1 and the other hydrogeologic framework maps in this report are modified from Miller (1982a, b, c, d, e). Miller mapped the areal extent of the top, base, and thickness of the aquifer system and separated the component aquifers and confining units on the basis of permeability contrasts. These permeability contrasts may exist anywhere within a rock unit (stratigraphic horizon or stage equivalent). Therefore, these maps may differ from previously published maps that portray the extent of carbonate sequences or particular geologic units that are not classified on the basis of permeability contrast.

Various geologic and time-stratigraphic units in different combinations make up the aquifer system in different places. The thickness of the aquifer system is represented by the composite thickness of several units having similar permeability characteristics, yet the number of units that make up the system, and their ages, may differ from place to place.

Miller (1982d) arbitrarily placed the updip limit of the aquifer system along a line where the aquifer system is generally less than 100 ft thick and where clastic units, which are facies of the limestone units, make up more than 50 percent of the section. In the updip part of the aquifer system, limestone becomes a small part of the section, being interbedded with calcareous sand and clay. Still farther updip, these units grade into units that are mostly clastic, are stratigraphic equivalents of the limestone, and have hydrologic properties somewhat similar to the limestone. In this updip area north and west of the line shown on plate 1 as the approximate updip limit of the aquifer system, there are thin beds and lenses of limestone that may be either connected to the main limestone body or isolated from it because of postdepositional erosion. Although these thin beds locally yield small to moderate amounts of water, they are not considered part of the Floridan aquifer system of Miller (1985). However, the thin limestone units and the clastic units in this updip area are included in the flow simulation in this study because of their local hydrologic significance.

Generally, in northeast Florida and southeast Georgia, rocks of the aquifer system consist of limestone and dolomite, having very little organic or argillaceous material (Chen, 1965, p. 75). In the northern part of the study area, the rocks of the lower part of the aquifer system are terrigenous clastics. In a northerly direction from a line trending east-northeast through Echols County, Ga., the limestone and dolomite become more argillaceous, then arenaceous, grading to calcareous clastics and finally to noncalcareous clastics at the outcrop belt along the Fall Line. The transition zone between the carbonate and clastic facies is the approximate northern extent of the thick carbonate platform that existed in the Florida peninsula during early Tertiary time. Between the predominantly terrigenous clastic and the predominantly carbonate areas and trending east-northeast through Echols County, Ga., is a thick sequence of Tertiary material, chiefly fine calcareous clastics and carbonates, that probably represents the Suwannee Strait described by Ewing and others (1966, p. 1969) and Husted (1972, p. 1558) or the Suwannee Channel described by Chen (1965, p. 10). The channel or strait was a factor influencing the distribution of these depositional facies. The effect of the channel or strait was most pronounced in Late Cretaceous time, and its effect decreased with time until it finally disappeared near the end of Eocene time. The transition zone between carbonate facies to the south and clastic facies to the north migrated northward from extreme southeast Georgia during Paleocene and Eocene time (Chen, 1965, p. 8, 9). The carbonate platform subsequently enlarged toward the north until finally, in late Eocene time, the carbonate facies had extended to a line approximated by the 100-foot aquifer-system thickness line (pl. 1).

The central part of the coastal area of Georgia, where the aquifer system is thick (pl. 1), lies in a depositional basin called the Southeast Georgia embayment. The altitude of basement rock is lower and all time-stratigraphic units in the Tertiary System are thicker in the embayment than in surrounding areas. Within this embayment, in the area of Brunswick, Ga., rocks of Paleocene and Late Cretaceous age are part of the Floridan aquifer system, resulting in a great thickness of the system in that area.

A significant feature affecting the thickness of the aquifer system is the Gulf Trough, first defined by Herrick and Vorhis (1963, p. 55) and later described by Gelbaum (1978, p. 39). The Gulf Trough trends northeastward within the study area from Colquitt County to Effingham County, Ga., and extends southwestward out of the study area to the panhandle of Florida. Simulation of the flow system indicates that the trough probably extends northeastward into South Carolina.

The Gulf Trough is a graben system caused by high-angle faulting that was active during much of the time of deposition of the rocks that make up the Floridan aquifer system (Gelbaum, 1978). Within the grabens are thick accumulations of low-permeability, clastic sediments and argillaceous carbonate rocks. Permeable, water-bearing units of the aquifer system are thus thinner within these grabens. (See pl. 1.)

Ground-water flow in the Floridan aquifer system is partially impeded by the Gulf Trough as a result of two mechanisms. First, near-vertical displacement of rocks along the faults of the graben system has juxtaposed rocks of lower permeability against the more permeable rocks of the aquifer system. Second, within the grabens the aquifer system consists of relatively low permeability material, which decreases the aquifer system's effective thickness.

Immediately downdip from the Gulf Trough, in the western part of the study area, the aquifer system is thin, ranging in thickness from about 400 to 900 ft (pl. 1). In this area the limestone of the lower part of the aquifer system contains evaporites, chiefly gypsum, that occur as nodules and lenses infilling the otherwise porous limestone (Krause, 1979). In this area, ground-water flow downgradient from the Gulf Trough was restricted and probably was not sufficient to produce the secondary porosity and permeability of the aquifer system as in other parts of the study area.

The limestone making up the Floridan aquifer system is thin in part of South Carolina, ranging in thickness from about 20 to 80 ft (pl. 1). In this area, the Upper Floridan aquifer is largely absent (Hayes, 1979, p. 28–30) and the Lower Floridan makes up the aquifer system. In a northeasterly direction from the extreme southern part of South Carolina, the Upper Floridan aquifer becomes thin and undergoes a facies change to low-permeability clastic rocks; the effect is that of a pinch-out of the Upper Floridan (Miller, 1985). Also, nearly all wells drilled in this part of South Carolina for water supply pass through the Upper Floridan and tap the Lower Floridan, where water is readily available. The northeasterly extent of the Upper Floridan (pl. 1) is marked arbitrarily by the reduction of the aquifer system's permeability and is shown on plate 1 by a dashed northwest-trending line whose location is based on widely scattered well control. In this area, the Lower Floridan aquifer consists of a thin permeable section at the base of the middle Eocene Santee Limestone.

An indication that the middle Eocene Santee Limestone is a significant aquifer in Orangeburg County, S.C., northeast of the Floridan aquifer system's extent as defined by this study, is documented by Siple (1975, p. 30). Siple (1975, p. 36) states that the Santee is the lithostratigraphic equivalent of the "Principal Limestone Aquifer" of Stringfield (1966, p. 95), which is basically equivalent to the Floridan aquifer system herein described. Siple (1975, p. 30, 36, 37) also states that the Santee is permeable and locally karstic, containing caves and springs near Lake Marion (located along the eastern county lines of Calhoun and Orangeburg Counties) and having transmissivity (estimated from specific-capacity data) as high as 5,000 ft^2/d. One well tapping the Santee was reportedly pumped at a rate of 600 gal/min with no appreciable drawdown (Siple, 1975, p. 40). In Colleton County, between the Orangeburg County area and the limit of the Floridan aquifer system defined in this report, Hayes (1979, p. 38–42) considers the upper permeable zone (Upper Floridan) to be thin and of low yield (less than 250 gal/min with more than 25 ft of drawdown). The lower permeable zone of Hayes (1979), equivalent to the Lower Floridan aquifer of this report, also yields small quantities of water. The specific capacities of eight wells tapping the Floridan aquifer system in Colleton County (Hayes, 1979, table 10) are less than 5 (gal/min)/ft. Thus, although rocks of the Santee Limestone in Orangeburg County northeast of the study area are probably stratigraphically equivalent to the Floridan aquifer system of the study area, and constitute a significant aquifer in both areas, they are not continuous and the Floridan probably extends only to its limit delineated in this study (pls. 1–4).

TOP OF THE AQUIFER SYSTEM

The top of the aquifer system as defined and mapped by Miller (1982d) represents the top of the highly permeable carbonate rock that is overlain by low-permeability material, either clastic or carbonate, which makes up the upper confining unit. Rocks of Oligocene age (Suwannee Limestone or equivalent) make up the top of the aquifer system over most of the central part of the study area. Rocks of late Eocene age represent the top of the aquifer system in most of northeast Florida and extreme southeast Georgia, and in small areas of Georgia and adjacent South Carolina where the Oligocene rocks have been stripped away by post-Oligocene erosion. Locally, in northeast Florida, small outliers of Oligocene rocks that were not eroded constitute the top of the aquifer system. Rocks of late Eocene age also make up the top of the aquifer system in east-central Georgia and adjacent South Carolina (pl. 2). Here, Oligocene rocks were not deposited, or were thin and readily eroded, or both. In part of the extreme updip Coastal Plain in Georgia and South Carolina,

calcareous clastic rocks of late Eocene age make up the top of the aquifer system (pl. 2). Here, the rocks consist of fossiliferous, argillaceous, glauconitic, calcareous clay and are part of the Barnwell Formation. Hydraulically, these beds, which are clastic facies of downdip carbonate rocks, do not represent a significant, corresponding change in permeability. Instead, these permeable clastic beds are hydraulically connected with the downdip carbonate rocks of the Upper Floridan aquifer.

In the extreme northeast part of the study area in South Carolina, the lower part of the Santee Limestone of middle Eocene age forms the top of the aquifer system (pl. 2). The Lower Floridan constitutes the permeable part of the aquifer system here.

BASE OF THE AQUIFER SYSTEM

In general, the base of the aquifer system is youngest in the updip part of the study area and is successively older downdip. The base of the aquifer system is oldest in the area of Brunswick, Ga., where it consists of evaporite beds and low-permeability dolomite of Late Cretaceous age. The altitude, configuration, and stratigraphy of the base of the aquifer system, chiefly as defined by Miller (1985), are shown on plate 3. In places, the base of the flow system differs slightly from the hydrogeologic base of the aquifer system as defined by Miller (1985). The predominantly clastic units, which lie both updip and below the predominantly carbonate rocks, are not a part of the Floridan aquifer system as defined by Miller (1985). They are hydraulically connected with the aquifer system, however, and thus were simulated during this study.

Rocks primarily of late Eocene age form the base of the aquifer system in the area downdip from the Gulf Trough in the western part of the study area (pl. 3). There, deposition of secondary gypsum has filled most of the pore space in the lower part of the Ocala Limestone and locally in the upper part of the Avon Park Formation. The Ocala is normally a highly permeable rock unit, and is the most productive of any of the formations in the Floridan aquifer system in the study area. Owing to the gypsum mineralization and the general lack of high secondary permeability, the lower part of the Ocala is a low-permeability unit to the southeast of the western part of the Gulf Trough within the study area. In that part of the area, the Ocala grades downward into low-permeability clastic rocks of the Lisbon Formation, and no Lower Floridan aquifer is present.

The base of the aquifer system near its updip limit in the northwestern part of the study area (pl. 3) is composed of fine-grained, calcareous, glauconitic sand interbedded with clay and argillaceous sand. These strata are part of the Lisbon Formation of middle Eocene age. Still farther downdip, the thickness of permeable material in the aquifer system increases and its base becomes progressively lower toward the southeast with respect to altitude and stratigraphic position. In a narrow northeast-trending strip across the central Georgia Coastal Plain, clastic rocks of the Lisbon Formation have graded by facies change into permeable limestone, which continues downdip. The base of the aquifer system in this transition zone consists of fine-grained, highly glauconitic sand, argillaceous sand, and clay, all of which are part of the Tallahatta Formation (pl. 3).

In the area along the Savannah River in Georgia and South Carolina (pl. 3), the base of the aquifer system is composed of highly sandy, calcareous clay interbedded with soft, sandy, argillaceous limestone and fine, calcareous sand. These rocks are time-equivalent to the Santee Limestone of South Carolina. Both the updip Lisbon and the downdip Tallahatta grade laterally into the Santee equivalent by facies change.

In these aforementioned areas where the base of the aquifer system is composed of middle Eocene rocks, permeable clastic units lying below the predominantly carbonate rocks are not a part of the aquifer system of Miller (1985) and are thus not shown on plate 3. They are, however, hydraulically connected with the downdip and the overlying carbonate facies of the Lower Floridan. Where such sands are present, the base of the Floridan aquifer system, for purposes of this study, lies within the Huber Formation in updip areas, and within either the Gosport equivalent, the Lisbon Formation, or the Tallahatta Formation in downdip areas.

Clastic rocks of early Eocene age form the base of the aquifer system in east-central coastal Georgia. These low-permeability rocks consist of silty, highly glauconitic, micaceous fine sand interbedded with lignitic clay. They are undifferentiated at present, but they are stratigraphic equivalents of the Tuscahoma and Nanafalia Formations of western Georgia and eastern Alabama. In the northern part of this area, permeable, clastic material of early Eocene age is hydraulically connected with the carbonate facies of the Lower Floridan.

The base of the aquifer system in south-central Georgia and adjacent counties in north Florida is represented by chalky, glauconitic, gypsiferous limestone and dolomite that are part of the Oldsmar Formation. Part of the Oldsmar grades northward and westward into equivalents of the Tuscahoma and Nanafalia Formations.

The Cedar Keys Formation of Paleocene age constitutes the base of the aquifer system in northeast Florida and extreme southeast Georgia. Rocks of the Cedar Keys Formation are dolomitic limestone and dolomite, having regionally extensive interbedded anhydrite layers that mark the base of the system. In

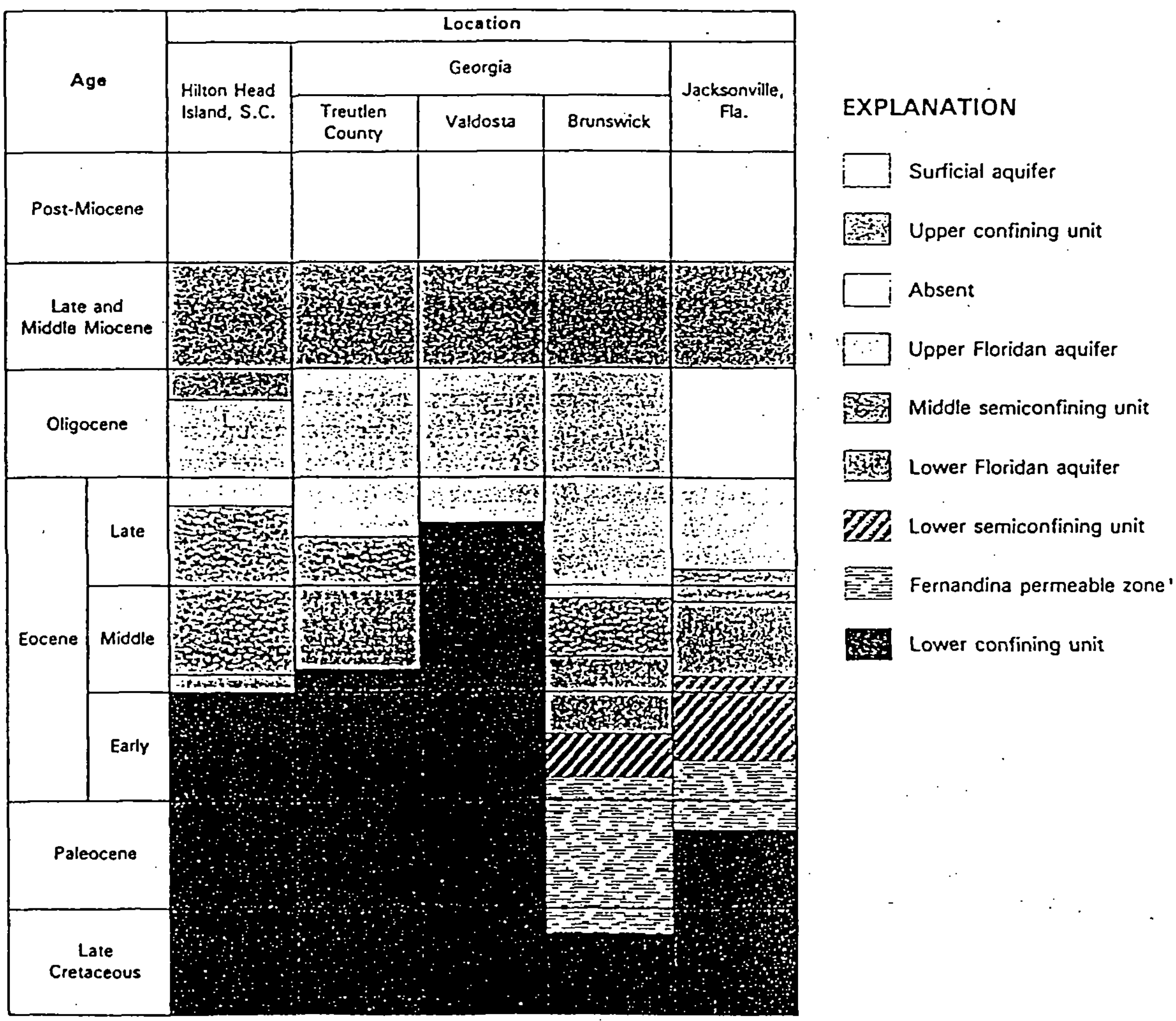
the extreme northeast part of the study area in South Carolina, the base consists of fine-grained, argillaceous, calcareous sand of the Black Mingo Formation.

Locally, in the area of Brunswick, Ga., the base of the aquifer system consists of soft, argillaceous, chalky limestone of Late Cretaceous (probably Tayloran) age. Younger, highly permeable, Late Cretaceous (Navarroan) calcarenite overlies the chalk and is part of the aquifer system.

AQUIFER-SYSTEM LAYERING

The Floridan aquifer system can generally be divided into upper and lower major permeable zones, called the Upper Floridan and the Lower Floridan aquifers, respectively. These aquifers are separated by what is termed the "middle semiconfining unit," whose age and lithologic character vary. In part of the study area, there is an extensive high-permeability zone within the Lower Floridan aquifer, herein formally designated the "Fernandina permeable zone" (pl. 3). The Fernandina permeable zone is everywhere overlain by a low-permeability confining unit of subregional extent. Although this confining unit is known to leak along local fractures, it otherwise effectively separates the Fernandina permeable zone from the overlying permeable beds within the rest of the Lower Floridan aquifer. Throughout most of the study area, the Floridan aquifer system is confined above by low-permeability clastic rocks of Miocene age. The system is everywhere underlain by a lower confining unit, which consists of low-permeability materials that may be evaporites, clastic rocks, or carbonate rocks. The age of the lower confining unit ranges from late Eocene to Late Cretaceous. (See table 3 and pl. 3.) The individual

TABLE 3.—*Aquifer-system layering*



¹ Part of Lower Floridan aquifer.

aquifers and confining units are shown on plates 4 and 5 and described below.

SURFICIAL AQUIFER

In most of the area where the Floridan aquifer system is confined, a surficial aquifer overlies the upper confining unit. The surficial aquifer consists of post-Miocene age, unconsolidated fine to very coarse, well-sorted sand, at depth commonly phosphatic and calcareous. In some areas, grain size is as large as fine gravel. Interbedded with these beds are layers of poorly sorted sand, clayey silt and sand, and, at depth, argillaceous limestone. In the extreme updip part of the study area, the upper confining unit is absent and the calcareous, clastic facies of the Floridan are largely unconfined. In this area, the Upper Floridan is under water-table conditions and supplants the surficial aquifer.

Water in the surficial aquifer is unconfined or under water-table conditions. The configuration of the water table is generally a subdued replica of the land surface. The water table is near land surface in low-lying areas, along streams, in marshes and swamps, and generally in areas along the coast. The water table also is near land surface in areas where the aquifer contains beds of low-permeability material. Generally, the water table is lower beneath topographic highs in areas of moderate to comparatively high relief. It is also lower where thick deposits of permeable material are present, such as along the Pleistocene shoreline ridges paralleling the coast. Relatively steep gradients in the water table adjoin the major stream courses, and relatively gentle gradients exist in the broad interstream areas.

In some areas where the clastic material overlying the Floridan aquifer system is thick, such as in the Southeast Georgia embayment, additional, partially confined permeable zones of clastic material are present within the upper confining unit and between the surficial aquifer and the Upper Floridan. Heads in these water-bearing zones may be higher or lower than heads in the surficial aquifer, depending on the degree of confinement, proximity of aquifers, withdrawal of water from the aquifers, and head gradient between the surficial aquifer and the Upper Floridan aquifer.

Precipitation infiltrates the surficial aquifer and moves down to the water table, providing the prime source of recharge to the aquifer. Water moves laterally downgradient and discharges into streams, ponds, and other surface-water bodies. Some water is lost to evaporation and transpiration, and some leaks downward into the Upper Floridan. The water level in the surficial aquifer responds rapidly to rainfall and shows seasonal variations corresponding to similar variations in rainfall and evapotranspiration. Seasonal fluctuations in the water level may be as great as 15 to 20 ft in areas of high topographic relief and where the aquifer is composed chiefly of coarse clastic, high-permeability material. Seasonal fluctuations are more commonly less than 10 ft in flat-lying areas and where low-permeability material is within, and especially near the top of, the surficial aquifer (fig. 7). Long-term climatic fluctuations in the water level in the surficial aquifer are probably negligible. Marked departures from normal precipitation (based on the period 1943–81) typically cause only a few feet of change in the water level (fig. 8).

The surficial aquifer functions as a source or sink to the underlying Floridan aquifer system, receiving water from or giving water to the Floridan. In areas where the water table in the surficial aquifer is above the potentiometric surface of the Floridan, the surficial aquifer recharges the Floridan by downward leakage through the upper confining unit. Where the head gradient between the surficial aquifer and the Floridan is in the opposite direction, the surficial aquifer receives upward leakage from the Floridan.

UPPER CONFINING UNIT

The upper confining unit consists primarily of the Hawthorn Formation of late and middle Miocene age, where present. It is composed of all strata between the surficial aquifer and the Upper Floridan aquifer, and thus includes not only clay of extremely low permeability but also, locally, sand beds of moderate permeability. In some areas, low-permeability beds of post-Miocene age are part of the upper confining unit. Over most of the study area, the unit is of middle Miocene age and consists of interbedded, locally highly phosphatic sand, silt, clay, and sandy clay beds of low permeability. The maximum thickness of the unit is about 600 ft in the Southeast Georgia embayment near Brunswick, Ga. (pl. 4).

The upper confining unit overlies all of the Floridan aquifer system except in the extreme updip part of the study area and in small areas where the confining unit has been breached or removed by erosion (pl. 4). These areas are not completely delineated by the lines of thickness of the upper confining unit shown on plate 4 because of the low density of control-well data. The thickness of the confining unit in the area of Brooks and Lowndes Counties, Ga., shown on plate 4 has been depicted with somewhat greater detail on the basis of work by Krause (1979, pl. 1). In Lowndes County, within the channel of the Withlacoochee River, the confining unit has been stripped away (pl. 4). In addition, some of the deeper sinkholes in the areas of thin confinement in the area of Lowndes County, as well as in the area of Keystone Heights, Fla., probably also breach the confining unit.

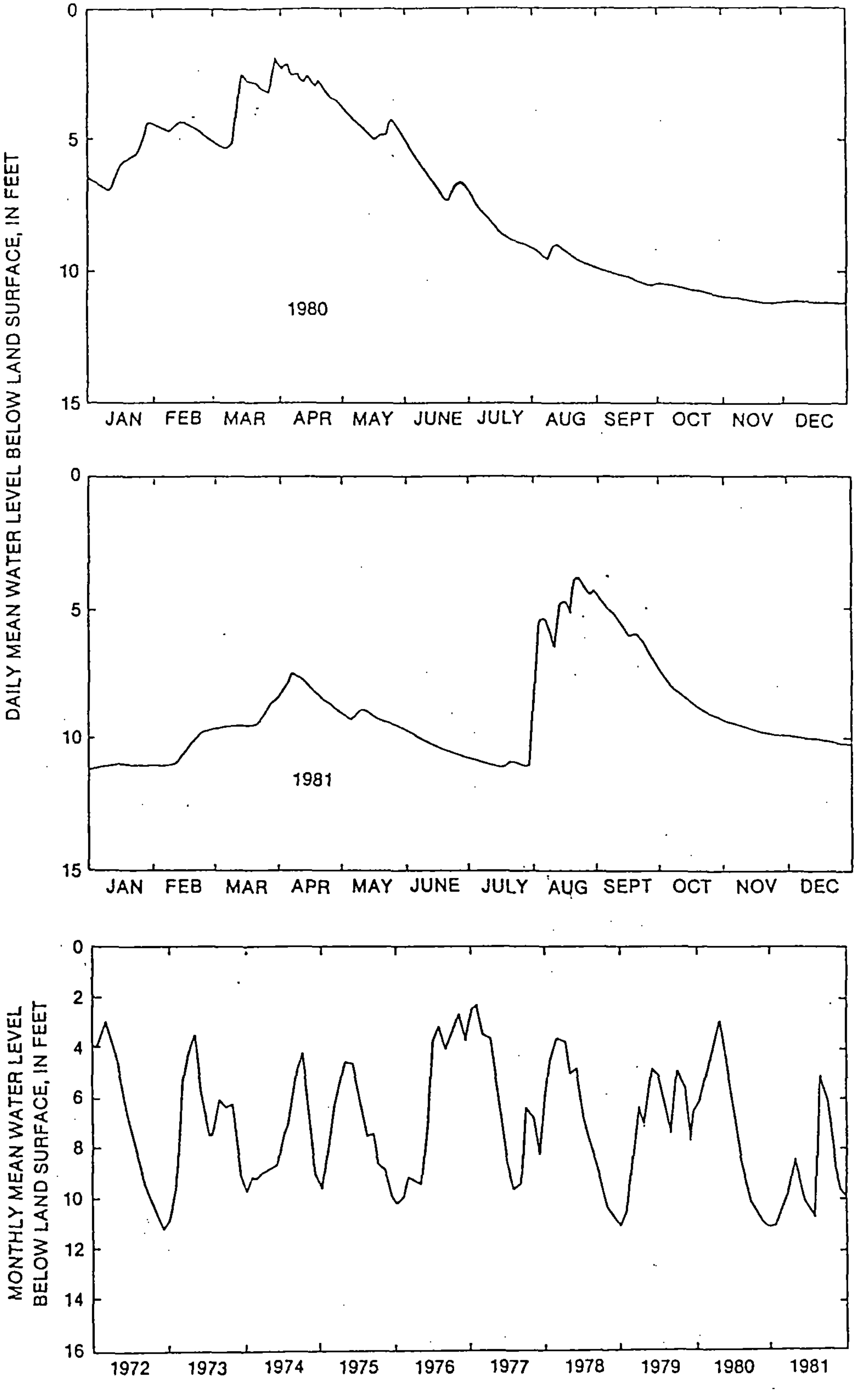


FIGURE 7.—Water-level fluctuations in the surficial aquifer, well 35P94, near Savannah, Ga.

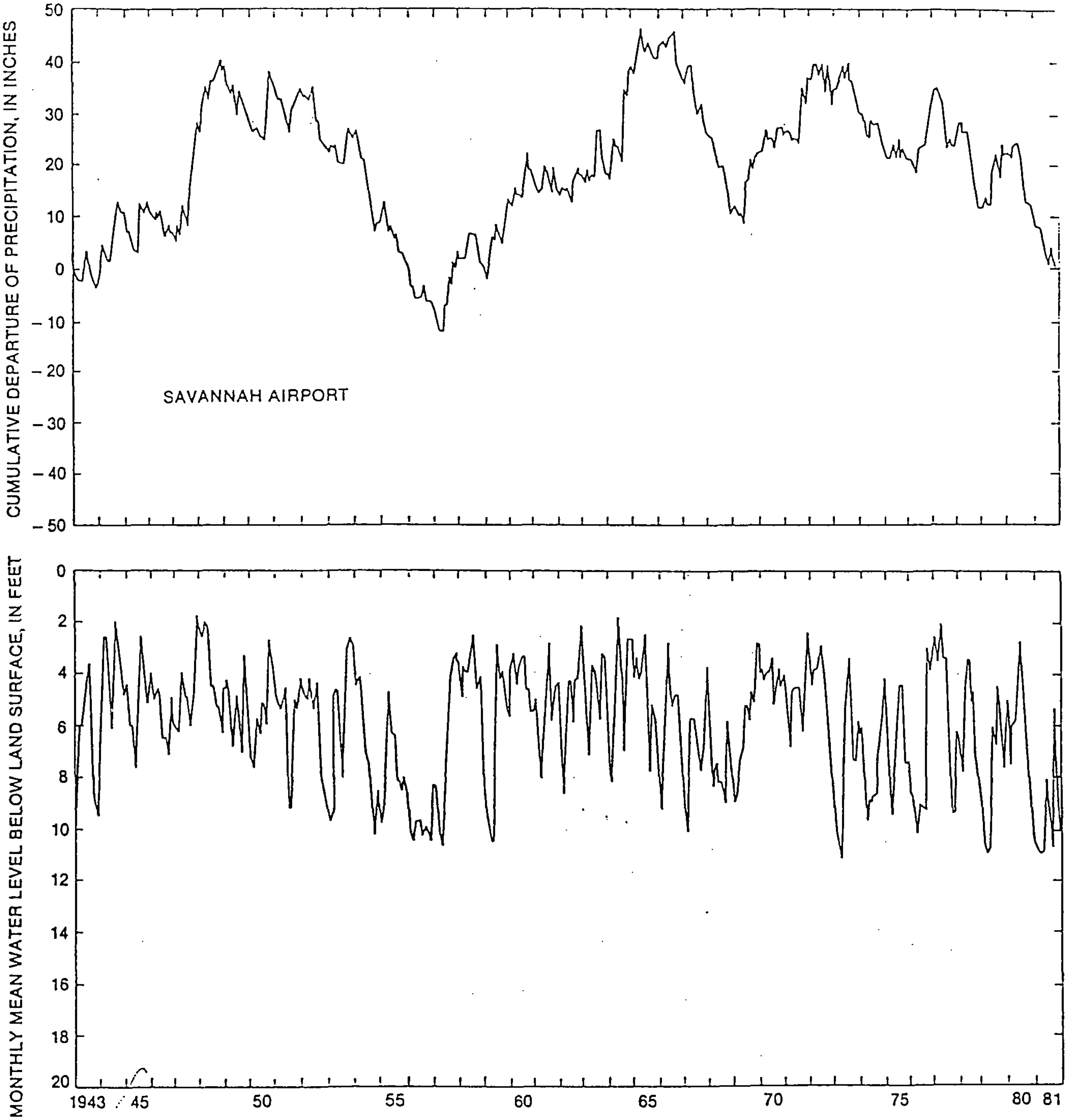


FIGURE 8.—Water-level fluctuations in the surficial aquifer, well 35P94, and cumulative departure of precipitation, Savannah, Ga., area, 1943–81.

In the area of Savannah, Ga., and Hilton Head Island, S.C., where the upper confining unit is thin, scouring action of creeks and estuaries, as well as the additional removal of material by dredging, has breached the upper confining unit (pl. 4) (Duncan, 1972, p. 103; Hayes, 1979, p. 30, 50; Randolph and Krause, 1984, p. 5).

In the part of South Carolina where the Upper Floridan aquifer is absent, the upper confining unit is mapped as an extension of the same late and middle Miocene and part of Oligocene strata that elsewhere compose the upper confining unit. Therefore, the thickness of the upper confining unit shown on plate 4 does not represent the entire thickness of the material overlying the Lower Floridan, but includes only the rocks that are chronostratigraphic equivalents of the upper confining unit.

The major updip rivers—Ocmulgee, Oconee, and Ogeechee in Georgia, the Savannah on the Georgia-South Carolina State line, and the Salkehatchee in South Carolina—also probably breach the confining unit, but the extent is largely unknown.

UPPER FLORIDAN AQUIFER

The Upper Floridan aquifer of the Floridan aquifer system consists chiefly of the Ocala Limestone and equivalents of late Eocene age. The Ocala, especially the upper part, is a very fossiliferous limestone having high effective porosity and permeability. Secondary permeability, which was developed by the migration of ground water along bedding planes, joints, fractures, and other zones of weakness, has made the Ocala extremely permeable.

In the area of Brunswick, Ga., the Upper Floridan consists of two permeable zones—the "upper and lower water-bearing zones" described by Wait and Gregg (1973, p. 16) and by Gregg and Zimmerman (1974, p. D17). The upper water-bearing zone includes the uppermost part of the Ocala and ranges in thickness from about 75 to 150 ft. It is a very fossiliferous, permeable limestone that contributes about 70 percent of the water to wells that tap both zones. The lower water-bearing zone includes the basal Ocala and the uppermost part of middle Eocene rocks, and ranges in thickness from about 15 to 110 ft. It is a recrystallized dolomitic limestone, less permeable than the upper water-bearing zone, and contributes about 30 percent of the water to wells that tap both zones. The two zones are treated as a single aquifer (Upper Floridan) in this study. Water-supply wells in the area of Brunswick generally do not tap water-bearing units beneath the Upper Floridan.

Although Miller (1985) included the Oligocene Suwannee Limestone, which overlies the Ocala, in the Upper Floridan in the area of Brunswick, the Suwannee is thin and yields insignificant quantities of water when compared with the upper and lower water-bearing zones.

In the area of Savannah, Ga., the Upper Floridan consists chiefly of two permeable zones—"zones 1 and 2" described by McCollum and Counts (1964, p. D9). These permeable zones were delineated on the basis of current-meter tests made in open holes in the Savannah area. Zone 1 is in the basal part of the Suwannee Limestone and the top part of the Ocala and is generally less than 50 ft thick. Zone 2 is near the middle of the Ocala and ranges from 25 to 75 ft in thickness. Zones 1 and 2 generally yield more than 70 percent of the water pumped from open holes tapping the entire aquifer system (McCollum and Counts, 1964). The two zones are treated together as the Upper Floridan aquifer in this study. Water-supply wells in the area of Savannah generally do not tap water-bearing zones beneath the Upper Floridan.

In the southern tip of South Carolina, the Upper Floridan is the "upper permeable zone" described by Hayes (1979) and Spigner and Ransom (1979). There, the Upper Floridan consists of the basal part (late Eocene age) of the Cooper Formation and the upper part of the Santee Limestone of middle Eocene age. The Upper Floridan is more than 200 ft thick in the extreme southern part of the area and thins toward the north until it pinches out near the Combahee River (pls. 1, 2, 5). The Upper Floridan is the primary source of ground water in most of the southern part of South Carolina.

In the northeast Florida area, the Upper Floridan consists of the Ocala Limestone (the "Ocala Group" of the Florida Geological Survey) (Leve, 1966, p. 11, 24). The Ocala is a sequence of permeable, hydraulically connected marine limestone that contains few low-permeability carbonate beds to restrict vertical movement of water (Leve, 1966, p. 24). The Upper Floridan contributes about one-half of the water pumped from wells tapping the entire Floridan aquifer system in the Jacksonville area. Head difference between the Upper Floridan and the underlying Lower Floridan is generally less than 2 ft in that area (Leve, 1966, p. 25). However, head differences between the Upper Floridan and the Lower Floridan may be as much as 20 ft in areas of large withdrawals from the Upper Floridan, such as that in the area of Fernandina Beach, Fla. (Fairchild and Bentley, 1977, p. 13).

In the western part of the study area, the Suwannee Limestone of Oligocene age forms the major part of the Upper Floridan aquifer. The Suwannee Limestone is similar in character to the Ocala but is more fossiliferous and somewhat sandy and phosphatic. The development of secondary permeability was similar to that in the

Ocala, making the Suwannee highly permeable. Secondary permeability is greatest at the erosional unconformity between the Ocala and the overlying Suwannee Limestone. The permeable zone at the Suwannee–Ocala unconformity is a major source of water in the Upper Floridan aquifer, especially in the area of Valdosta, Ga. (Krause, 1979, p. 10). An erosional unconformity containing highly developed secondary permeability is also present between the Suwannee and the overlying sandy limestones of early Miocene age in the Valdosta area. This zone is also a significant part of the Upper Floridan in that area (Krause, 1979, p. 10). In the Valdosta area, the Upper Floridan aquifer is the sole producing zone in the Floridan aquifer system. There, the Lower Floridan has low permeability and a sluggish, nearly static flow system that is isolated from the rest of the aquifer system, contains mineralized water, and herein is not considered part of the aquifer flow system.

In the extreme updip part of Georgia, the Upper Floridan aquifer consists chiefly of the Barnwell Formation of late Eocene age, which grades by facies change to the Ocala Limestone. The Upper Floridan extends updip to the late Eocene facies that consists of less than 50 percent carbonate (Miller, 1982d). The Oligocene Suwannee Limestone is a minor part of the Upper Floridan in all but the extreme updip area.

LOWER FLORIDAN AQUIFER AND MIDDLE SEMICONFINING UNIT

The Lower Floridan over most of the study area consists chiefly of middle to lower Eocene carbonate rocks, less fossiliferous and more dolomitic than the overlying Upper Floridan. Permeability is primarily secondary and is developed along bedding planes and other zones of weakness. The Lower Floridan is an insignificant contributor to wells tapping the entire Floridan aquifer system except in the area of Jacksonville, Fla., and east of the Combahee River in South Carolina. In extreme southeast Georgia and northeast Florida, the Lower Floridan includes a mappable water-bearing zone, formally designated the "Fernandina permeable zone." This zone, lying at the base of the Lower Floridan aquifer, is distinctive in its flow characteristics in this study area and is considered a separate water-bearing unit. Discussions of the Lower Floridan in this section exclude the Fernandina permeable zone, which is discussed in the following section.

In the updip part of the study area, the Lower Floridan as defined by Miller (1982b; 1985) does not exist. In parts of the updip area, Miller combined the Upper and Lower Floridan and termed them the "Upper Floridan." In other parts of the updip area, he excluded the Lower Floridan from the aquifer system because rocks that make up the water-bearing zone consist chiefly of clastic material. For this study, the Lower Floridan is considered a separate unit and, even where clastic, a part of the active flow system.

In the area of Jacksonville, Fla., the Lower Floridan (exclusive of the Fernandina permeable zone) consists chiefly of the middle Eocene Lake City Limestone of former usage (Leve, 1966, p. 29). The Lake City, as formerly used, was not differentiated stratigraphically from the overlying Avon Park Formation (also of middle Eocene age) in this report or in Miller (1985). However, Leve (1966, p. 14) made the distinction between the Lake City and the Avon Park on the basis of foraminifera. Miller (1985) abandoned the name Lake City Limestone and included the entire middle Eocene section in the Avon Park Formation—"formation" rather than "limestone" because the Avon Park contains significant amounts of dolomite. This report follows that usage. Lithologically, the entire middle Eocene section consists of alternating beds of limestone and dolomite, the lower part having well-developed secondary permeability.

The Lower Floridan is about 500 ft thick in the Jacksonville area, lying about 950 to 1,400 ft below land surface (Leve, 1966, p. 29). Within the Lower Floridan are zones of high and low permeability. Leve (1966, p. 29) reported that two permeable zones exist in this sequence—an upper zone between about 950 and 1,200 ft below land surface and a lower zone between about 1,250 and 1,400 ft. As described by Leve (1966), the two zones are separated by hard limestone and dolomite in the Lake City (of former usage) and have somewhat different head and yield characteristics.

The Lower Floridan is confined above by hard, low-permeability limestone and dolomite of the upper part of the middle Eocene Avon Park Formation (Miller, 1985) and the basal part of the upper Eocene Ocala Limestone (Leve, 1966). This hard, low-permeability limestone, called the middle semiconfining unit, is of sufficiently low permeability to cause some head difference between the Upper and Lower Floridan. (See discussion of Jacksonville area in earlier section on the "Upper Floridan Aquifer.") This semiconfining unit locally is breached by faults or fractures that facilitate leakage, generally from the Lower to the Upper Floridan, where the head difference is sufficient. (Leakage is discussed in a later section.) About one-half of the water pumped by large municipal and industrial wells in the Jacksonville area is withdrawn from the Lower Floridan.

The Lower Floridan in the area of Fernandina Beach, Fla., is similar to that in the Jacksonville area, except there is no confinement within the Lake City Limestone (of former usage; Leve, 1966, p. 30) and the Lower Floridan is more deeply buried. Almost no water is withdrawn from the Lower Floridan in the Fernandina

area; however, the zone leaks water to the Upper Floridan where the Upper Floridan is heavily pumped.

The Lower Floridan in the area of Brunswick, Ga., consists of interbedded limestone and dolomite of the lower two-thirds of the middle Eocene, and the upper part of the lower Eocene. The Lower Floridan in this area includes the "brackish-water zone" and the "deep freshwater" described by Gregg and Zimmerman (1974, pl. 1). Neither of these zones is tapped by supply wells in the Brunswick area, but water from the zones leaks upward through faults or fractures in the middle semiconfining unit into the Upper Floridan. The middle semiconfining unit consists of dense, low-permeability, recrystallized limestone and dolomite near the top of the middle Eocene section.

In the area of Savannah, Ga., and Hilton Head Island, S.C., the Lower Floridan consists of dolomitic limestone of middle Eocene age. In the Savannah area, the Lower Floridan represents permeable zones 3, 4, and 5 described by McCollum and Counts (1964, p. D9), as determined from current-meter tests made in wells. The Lower Floridan is not tapped for water supply in the Savannah area. However, it responds to pumping from the Upper Floridan, as indicated by the similarity of water levels observed in the Upper and Lower Floridan aquifers (fig. 9). This suggests that the Lower Floridan is hydraulically connected with the Upper Floridan.

In the area of Hilton Head Island, S.C., the Lower Floridan is similar to that at Savannah, but individual permeable zones have not been reported. The Lower Floridan in this area is the "lower permeable zone" described by Hayes (1979) and Spigner and Ransom (1979), which is the Santee Limestone of the basal middle Eocene. The lower permeable zone consists of a siliceous, glauconitic limestone having secondary permeability. It is less than 100 ft thick in this area. In the extreme northeastern part of the study area in South Carolina, the Upper Floridan is not present (pls. 1, 5) and the Lower Floridan is the primary source of ground water. The middle semiconfining unit there is a soft, siliceous, argillaceous, marly limestone of low permeability that ranges in thickness from about 200 to 900 ft.

Downdip from the Gulf Trough in middle Georgia, the Lower Floridan consists chiefly of siliceous, argillaceous limestone of middle Eocene age. The Lower Floridan, as a permeable carbonate facies within the entire Floridan aquifer system, extends only to about the Gulf Trough. Updip from the Gulf Trough, the character of rocks stratigraphically equivalent to the downdip carbonate facies changes considerably. In the updip area, the aquifer grades northward from a carbonate facies along the trough to clastic facies along the updip extent of the aquifer system.

Updip from the Gulf Trough, the Lower Floridan, according to Miller's (1985) framework of the aquifer system, does not exist. In that area, Miller limited the Floridan aquifer system to strata that are more than 50 percent carbonate. Although the units in this area are predominantly noncarbonate and are designated by different formation names, they are the clastic equivalents of Miller's Lower Floridan, differing only in lithology. The units are hydraulically part of the Lower Floridan flow system and therefore are treated as part of the Lower Floridan in this study. The clastic units consist of calcareous silt and sand, fossiliferous, glauconitic, sandy limestone, and clean quartz sand and gravel having high porosity and permeability. The units are chiefly part of the Huber Formation (Buie, 1978), the exact age of which is unknown, which occurs between two recognizable unconformities—one at the end of the Cretaceous and one at the end of the middle Eocene.

The middle semiconfining unit overlying the Lower Floridan is made up of low-permeability clay, siltstone, and argillaceous limestone of the basal part of upper Eocene strata. The unit grades into the adjacent Upper and Lower Floridan, and in places has moderate permeability and effective vertical hydraulic conductivity, in effect providing little separation between the aquifers.

Little is known of the extent, thickness, and character of similar facies of the Lower Floridan and the middle semiconfining unit in the inland part of the study area. Few data are available for the Lower Floridan and middle semiconfining unit, as only a few wells tap the Lower Floridan, especially in this inland area. Sufficient water supplies are generally obtained from the Upper Floridan, making drilling into the Lower Floridan unnecessary. Some oil-test wells have been drilled through the Lower Floridan; however, only geologic and geophysical data were obtained.

Fernandina Permeable Zone

The Fernandina permeable zone of the Lower Floridan aquifer was first tapped in 1945 by a 2,130-ft test well at Fernandina Beach, Fla., and that name is used herein. The zone consists of pelletal, recrystallized limestone and finely crystallized dolomite that has extremely high permeability and is locally cavernous. In the areas of Fernandina Beach and Jacksonville, the zone is in the basal lower Eocene and Paleocene—the Oldsmar and Cedar Keys Formations, respectively. In the area of Brunswick, Ga., the zone is lower stratigraphically and lies at a greater depth in rocks of Paleocene and latest Cretaceous age. Thickness of the zone ranges from about 100 ft in the Jacksonville area to more than 500 ft at Brunswick. The zone's approximate extent is shown on plate 3. The offshore extent

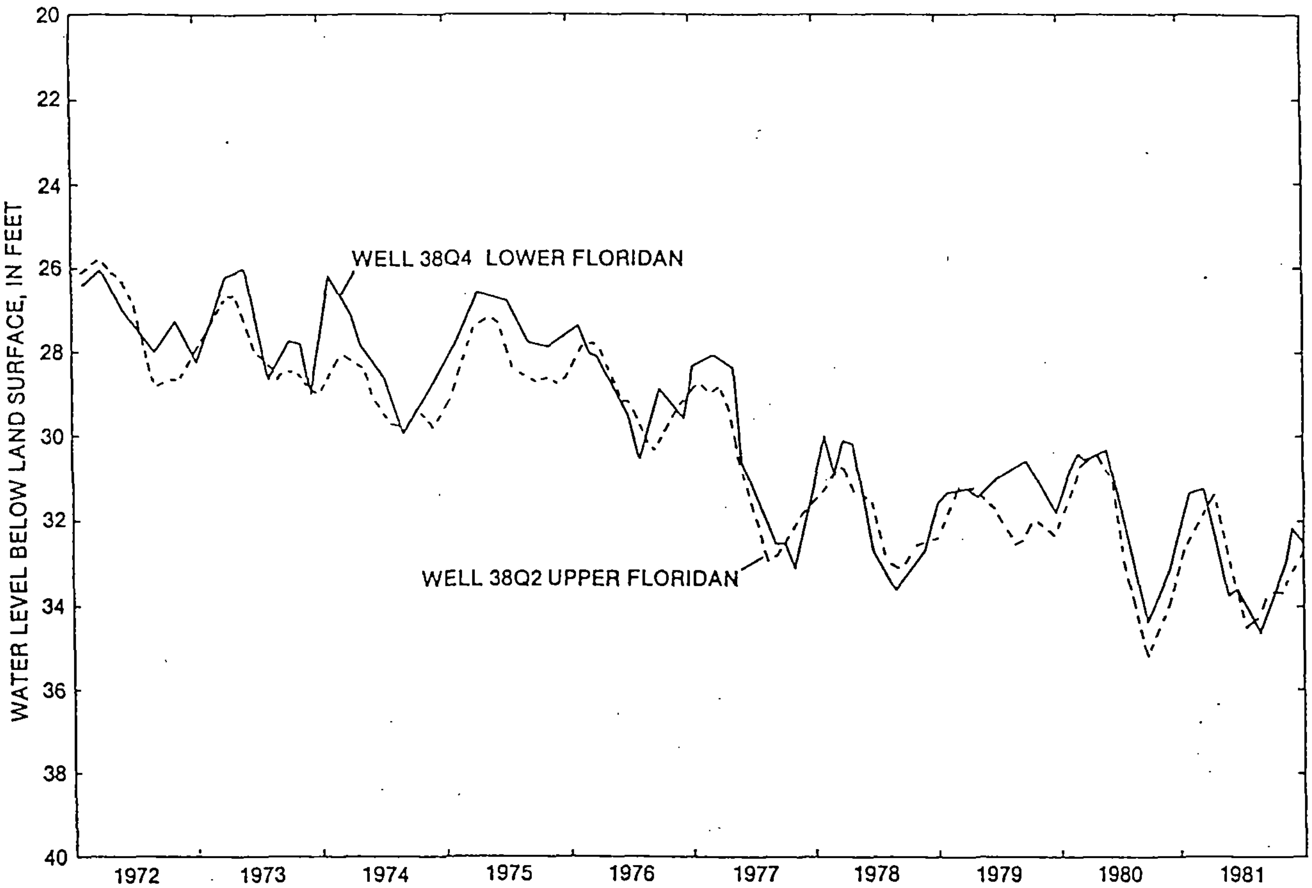


FIGURE 9.—Comparison of water levels in the Upper and Lower Floridan aquifers, Savannah, Ga.

of the zone is unknown, but it undoubtedly extends some distance offshore and may crop out on the ocean floor. Miller (1985) states that the semiconfining unit overlying the Fernandina permeable zone pinches out toward the south and southwest in Florida, and that the zone merges with the rest of the Lower Floridan aquifer.

Because few wells tap the Fernandina permeable zone, very little is known about its extent, thickness, and characteristics. Definition of the zone on the basis of geophysical logs is also made difficult because of the varying and largely unknown quality of its water and occurrence of cavernous zones.

The Fernandina permeable zone is confined above by low-permeability rocks of lower-middle to early Eocene age consisting chiefly of limestone and dolomite, nearly the same as the permeable zones adjacent to it. Vertical hydraulic conductivity of the lower semiconfining unit overlying the Fernandina permeable zone is low, except where it has been breached by faulting.

HYDRAULIC CHARACTERISTICS

Like the geologic data, the hydraulic characteristics of the Floridan aquifer system are primarily known for the Upper Floridan aquifer and the upper confining unit. Very few data are available for the middle and lower semiconfining units and the Lower Floridan aquifer. Almost all aquifer tests conducted in the Floridan in the study area have been of the Upper Floridan. Of these tests, most were made in wells penetrating the upper part of the Upper Floridan. No aquifer tests have been made exclusively in the Lower Floridan. Only one aquifer test, conducted near Waycross, Ga., as part of this study, has been made in wells that tap the entire thickness of the Floridan aquifer system.

Hydraulic characteristics of the Floridan aquifer system vary greatly within the study area, owing to the heterogeneity (and locally to the anisotropy) of the

aquifers and to the confinement (or lack of confinement) provided by the confining units.

AQUIFERS

Hydraulic conductivity and transmissivity of the Upper and Lower Floridan aquifers are generally lowest in the areas of outcrop, along the extent of the aquifers in South Carolina and probably offshore and along the Gulf Trough. Hydraulic conductivity and transmissivity generally increase downdip and downgradient from the Gulf Trough throughout Georgia, then decrease near the Florida–Georgia State line, and finally increase farther south in northeast Florida.

The heterogeneity of the aquifer system is chiefly related to the development of secondary porosity and permeability in the carbonate rocks. Secondary porosity and permeability are developed by circulating ground water as it flows through bedding-plane separations, faults, joints, fractures, and other zones of weakness in the carbonate and enlarges them by solution. Anisotropy of the aquifer is, in places, enhanced by the preferential orientation of structural features along which ground water flows. In the area of Valdosta, Ga., Krause (1979, p. 9) concluded that uplift during the Miocene produced northwest–southeast- and northeast–southwest-trending joints along which preferential ground-water flow developed. The directions of preferential flow are indicated by trends in surface drainages, alignments of karst physiographic features, and areal variations in water quality.

Cavities, cavernous zones, and solution channels tens of feet in vertical and horizontal dimensions have been tapped by wells throughout the downgradient part of the Floridan aquifer system in southeast Georgia and northeast Florida. These zones are chiefly in the Upper Floridan, but some of the largest are in the Lower Floridan and its Fernandina permeable zone in extreme southeast Georgia and northeast Florida. Most of the cavernous zones and solution channels are oriented in the horizontal plane, enhancing lateral permeabilities. However, some solution channels are oriented along nearly vertical planes and probably formed along zones of weakness caused by high-angle fractures and faults. These nearly vertical conduits locally connect permeable zones within the entire Floridan aquifer system along the coast in extreme southeast Georgia and in northeast Florida. Although faults are believed to be present along the southeast Georgia coast (D.C. Prowell and H.E. Gill, U.S. Geological Survey, written commun., 1983), they have not been mapped by Miller (1985) and are not shown on the structure maps in this report.

Conversely, structure in the form of nearly vertical faulting has locally decreased the lateral permeability of the aquifer system. The most pronounced effects of faulting and lateral permeability reduction in the aquifer system are in the area of the Gulf Trough. There, high-angle faults probably have juxtaposed permeable zones nearly opposite to zones of low permeability, markedly decreasing what probably had been continuous lateral permeability. Infilling of low-permeability clastic material in the grabens further decreased permeability. Even in the downgradient area along the southeast Georgia–northeast Florida coast, where only carbonate rocks of the aquifer system were faulted, some of the high-angle faulting has probably decreased lateral permeability.

Hydrogeologic differences within the Upper and Lower Floridan aquifers result in large variations in hydraulic properties within short distances. Estimated hydraulic conductivity increases from less than 5 ft/d in the western part of the Gulf Trough to greater than 500 ft/d less than 10 mi downdip from the trough (pl. 7). Hydraulic properties vary in even shorter distances because of the extreme areal variability of secondary porosity and permeability. The transmissivity values derived from some of the aquifer tests did not approximate the regional transmissivity values simulated during this study. Some values obtained from aquifer tests are considerably lower than those simulated. Probable causes of this discrepancy are that these aquifer tests were too short, or were conducted on wells that partially penetrated the aquifer or that tapped parts of the aquifer lacking fractures or solution conduits that control flow on the regional scale.

The transmissivities shown on plate 7 are from a variety of sources. In order of descending reliability, those sources are (1) multiwell aquifer tests using the Theis analysis, (2) single-well aquifer tests using the Cooper-Jacob approximation, and (3) estimation from specific-capacity data. Bush and Johnston (in press) used a statistical analysis of transmissivity values of the Floridan aquifer system and concluded that the relation between transmissivity values estimated from specific-capacity data and those obtained from simulation was minimal, and that the transmissivity estimated from specific capacity is almost always less than that from simulation. They also concluded that transmissivity values derived from aquifer tests were slightly less than those simulated, but that they were in better agreement with simulated values than were those estimated from specific-capacity data. Specific capacity is thus not a particularly good basis from which to estimate transmissivity in most parts of the Floridan aquifer system. Transmissivities obtained from multiwell aquifer tests (where pumping and observation wells are hundreds of

feet apart) more nearly equal the simulated transmissivity values, which represent the regional flow system.

Hydraulic conductivity of the Upper Floridan shown on plate 7 was estimated from aquifer tests and ranges from less than 5 ft/d to more than 1,000 ft/d. Transmissivity ranges from less than 1,000 ft^2/d to nearly 1,000,000 ft^2/d (pl. 7). Actual ranges of hydraulic conductivity and transmissivity, which control ground-water flow on a regional scale, are probably greater. Hydraulic conductivity and transmissivity approach zero at the outcrop limit of the aquifer, where thickness approaches zero, and become extremely large near springs and swallow holes, where water moves through solution channels as much as tens of feet in diameter.

Most of the data on plate 7 are from aquifer tests made along the heavily developed and intensively studied coast. Because of the paucity of data on hydraulic properties of the aquifer system in the inland area, an aquifer test was conducted during this investigation at an area of suspected high transmissivity near Waycross, Ga. The two wells constructed for the test penetrated the entire Floridan aquifer system. However, all of the flow was derived from the Upper Floridan aquifer. Matthews and Krause (1984) describe the test drilling and aquifer testing in detail. Only a brief summary of the aquifer test follows.

The aquifer test was conducted June 16–19, 1981, at a site about 9 mi southeast of Waycross, Ga. (pl. 7), where the Floridan aquifer system is moderately thick and the transmissivity was believed to be very large. The aquifer system is about 1,250 ft thick, extending from about 600 to 1,900 ft below land surface, which has an altitude of about 150 ft.

A nearly constant rate of 2,040 gal/min was maintained in the pumped well for 47 h. Water-level measurements were made in the observation well, 154 ft away, throughout the pumping and recovery periods. The orifice method was used to measure the pumping rate. Electric and wetted-tape methods and water-level recorders were used for water-level measurements.

Complicating factors during the test included (1) minimal water-level decline of less than 0.5 ft in the observation well, (2) cyclic fluctuations in the water level (probably the result of earth tides) nearly as great as the decline induced by pumping, and (3) a seasonal water-level decline that encompassed the test period. These factors precluded the determination of definitive values of the aquifer properties.

Figure 10 is a plot of the drawdown adjusted for the regional water-level decline versus time for the observation well. The cyclic water-level fluctuations were not the result of barometric fluctuations (Matthews and Krause, 1984, p. 13, fig. 3) but, as stated, were probably caused by earth tides. These fluctuations were ignored and the Theis-type curve was superposed through a graphic median of the data as shown in figure 10.

Using the match points for the Theis curve and associated parameters shown in figure 10, the transmissivity was calculated to be about 1,000,000 ft^2/d. A storage coefficient of 0.0001 was calculated, but its accuracy is questionable. It is, however, similar to values reported elsewhere in the thickly confined area. Although the aquifer test was conducted using wells that fully penetrated the Floridan aquifer system, a borehole-flowmeter survey taken when the pumping well discharged 1,900 gal/min indicated negligible (unmeasurable) flow from depth below about 1,100 ft. This indicates that the discharge is entirely from the Upper Floridan aquifer.

The transmissivity determined from this aquifer test is the largest ever derived from a pumping test for the freshwater interval of the Floridan aquifer system. Higher values have been determined by areal, flow-net methods in the area of springs in north-central Florida. Faulkner (1973, p. 93–96) determined transmissivity by flow-net analysis to be an average of more than 2,000,000 ft^2/d around Silver Springs. One segment of the flow net had an estimated transmissivity of more than 25,000,000 ft^2/d.

Although undetermined to date, higher transmissivity also probably exists along the coast in southeast Georgia. Highest hydraulic conductivities in the study area are recorded there (pl. 7) and the Floridan aquifer system, which includes rocks of Late Cretaceous age, is thickest there (pl. 1). Caliper and sonic televiewer logs and borehole television traverses made in a test well near Brunswick, Ga., showed extensive caverns throughout the Floridan aquifer system.

In contrast to these extremely large transmissivities, values of less than 1,000 ft^2/d in the area along the Gulf Trough have been determined by estimates from specific-capacity data. Low values are expected there because of faulting, juxtaposition of permeable and nonpermeable zones, and clastic infilling. Low transmissivity also occurs in the outcrop areas and at the physical limits of the aquifer due to thinning of the aquifer system. The areal distribution of transmissivity of the Upper Floridan aquifer as simulated by the flow model is shown on plate 8. The transmissivity distribution is in good agreement with those derived from field data (pl. 7).

Transmissivity data for the Lower Floridan aquifer are nearly nonexistent. Estimates of transmissivity were based primarily on thickness and qualitative estimates of permeability made from geophysical well logs. Transmissivity of the Lower Floridan aquifer probably ranges from about 2,000 ft^2/d to nearly 400,000 ft^2/d.

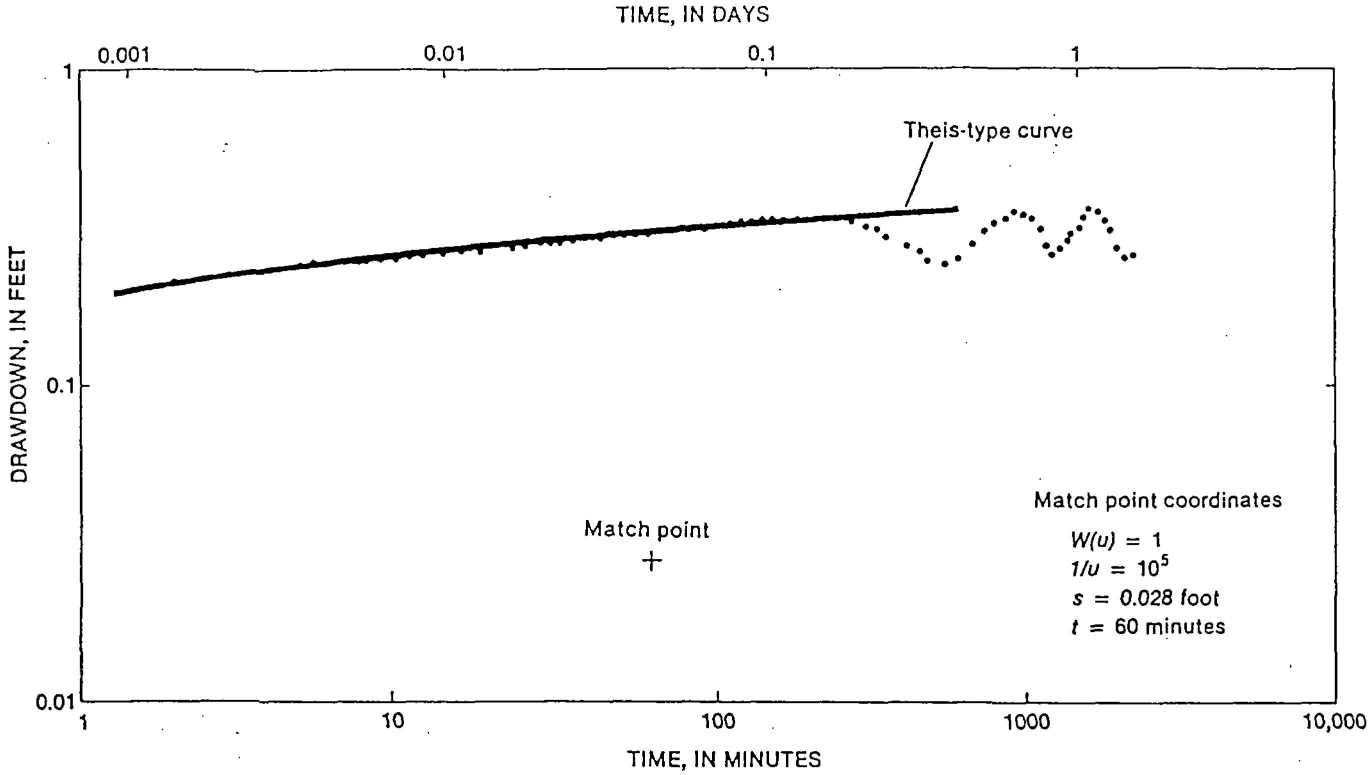


FIGURE 10.—Logarithmic plot of drawdown (s) in the observation well versus time (t) from the Waycross aquifer test, superposed on the Theis type curve (nonleaky, artesian). From Matthews and Krause (1984).

Transmissivity of the Lower Floridan generally decreases from south to north within the carbonate sequence downdip from the Gulf Trough. It is highest in northeast Florida, especially in the area of Jacksonville, where it is nearly 400,000 ft²/d and the Lower Floridan yields about half the water withdrawn there from the Floridan aquifer system. The transmissivity of the Lower Floridan is probably less than 100,000 ft²/d everywhere except in northeast Florida and extreme southeast Georgia. In the Savannah, Ga., area, the transmissivity of the Lower Floridan is probably less than 10,000 ft²/d. Because the Lower Floridan includes thick sequences of permeable clastic material near the outcrop area of the aquifer system, transmissivity of the Lower Floridan is higher there than it is downdip in most of central Georgia. Transmissivity values there range from about 10,000 to 40,000 ft²/d, based on simulation.

Transmissivity of the Fernandina permeable zone is less well known than that of the rest of the Lower Floridan. The hydrogeology of the Fernandina permeable zone based on borehole geophysical data gives some indication of the relative transmissivity of the zone. Borehole television and caliper logs of a test well 3 mi southwest of Brunswick, Glynn County, Ga., showed cavities, or conduits, in the Fernandina permeable zone that were tens of feet in height and of undetermined lateral extent. A similar cavernous zone in the Lower Floridan in South Florida has a transmissivity greater than 3,000,000 ft²/d (Meyer, 1974). Borehole geophysical logs indicate that the Fernandina permeable zone is cavernous and has high permeability in northeast Florida, although somewhat less than at Brunswick. Transmissivity probably decreases markedly from those areas and approaches zero at the limit of the zone's extent. Also, if the zone extends toward the south and southwest in Florida and merges with the rest of the Lower Floridan aquifer (Miller, 1985), its transmissivity would not, of course, approach zero in that area.

CONFINING UNITS

Hydraulic data for the confining units are more sparse than those for the aquifers. Except for laboratory analyses of the vertical hydraulic conductivity of cores

from the middle semiconfining unit at Brunswick, Ga. (Wait and Gregg, 1973, p. 42), the only data available are for the upper confining unit.

In Brunswick, Ga., vertical hydraulic conductivity of the upper confining unit, as determined by laboratory analyses of cores, ranged from 5×10^{-5} ft/d (Wait, 1965, p. 48) to 1.1 ft/d (Wait and Gregg, 1973, table 9). Vertical hydraulic conductivity suggested by simulation is about 1×10^{-5} to 1×10^{-3} ft/d. A hydraulic conductivity of 1×10^{-4} ft/d for a 475-ft confining-unit thickness results in a leakance of 2.1×10^{-7} d^{-1}. A 25-ft head difference between the surficial and the Upper Floridan aquifers would effect leakage of about 0.02 in/yr through the upper confining unit.

An average vertical hydraulic conductivity of 1.3×10^{-3} ft/d was determined by laboratory analyses of 52 cores taken from the upper confining unit (Miocene Hawthorn Formation) at various locations in Chatham County, Ga. (Furlow, 1969, p. 23). The cores were taken from within a 40-ft sequence of a fuller's earth type of clay that probably represents the least permeable part of the upper confining unit. The average hydraulic conductivity of the entire upper confining unit is undoubtedly greater than the laboratory-determined values because of the presence of more permeable strata in the unit. Leakance of the 40-ft sequence having a vertical hydraulic conductivity of 1.3×10^{-3} ft/d would be 3.2×10^{-5} d^{-1}. Leakage through the sequence under the prevailing vertical head difference of 15 ft would be 2.1 in/yr.

In the area of Baker and Columbia Counties, Fla., just southwest of the study area, vertical hydraulic conductivity of the upper confining unit (Hawthorn Formation) was determined by laboratory analyses of cores to range from 1.5×10^{-2} to 7.8×10^{-7} ft/d, and by extensometer analysis to be about 2×10^{-4} ft/d (Miller and others, 1978, table 17).

An estimated conductivity of 1×10^{-4} ft/d for the 10-ft "D member" of the Hawthorn Formation (Miller and others, 1978) results in a leakance of 1×10^{-5} d^{-1}. Leakage through that unit would be 0.04 in/yr under the prevailing vertical head difference of 1 ft. The hydraulic conductivity of 2×10^{-4} ft/d from the extensometer analysis, for the 14-ft "Lower B member" of the Hawthorn results in a leakance of 1.4×10^{-5} d^{-1} (Miller and others, 1978). Leakage through that unit would be about 0.06 in/yr under the 1-ft head difference.

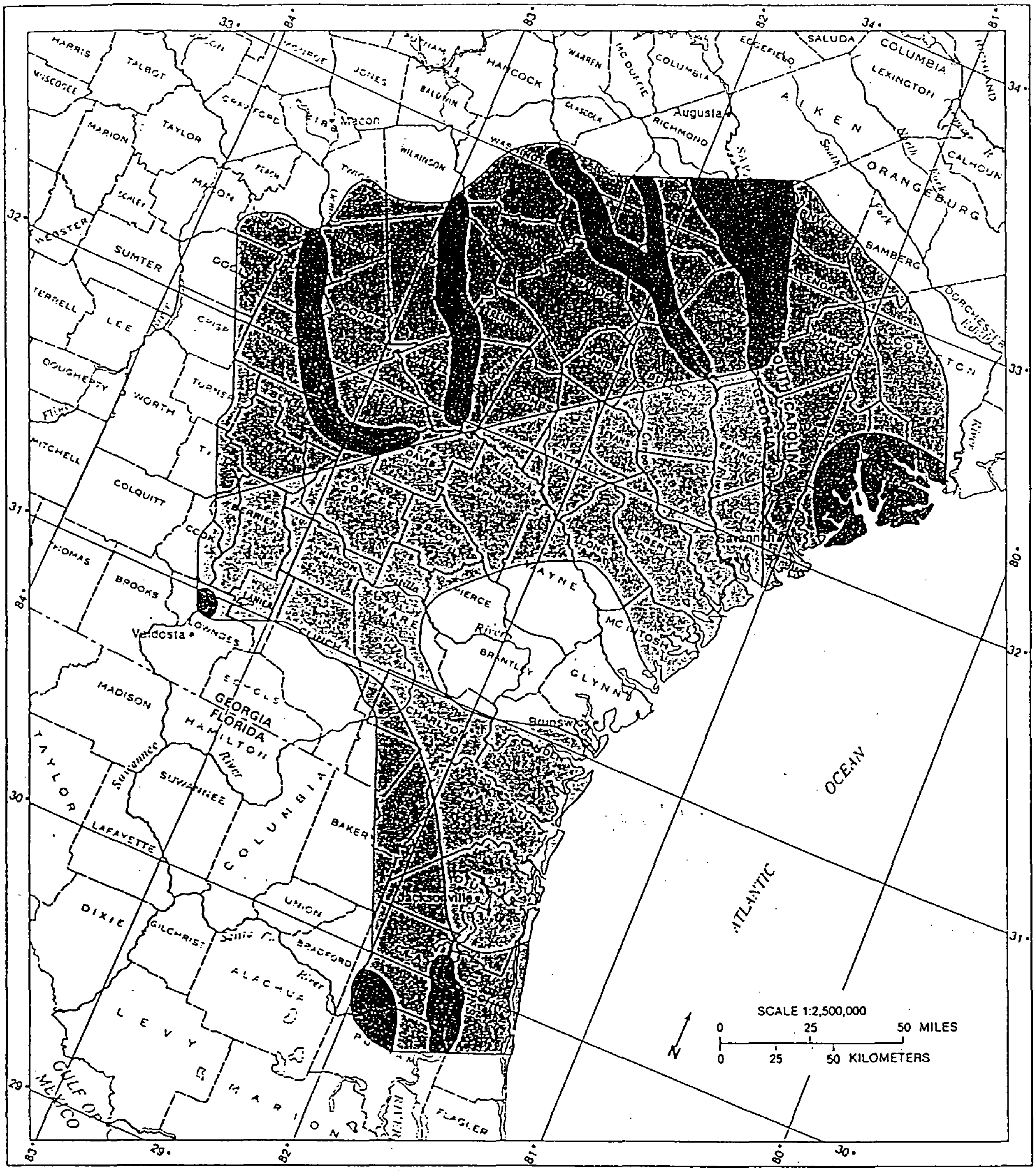
In the southern part of St. Johns County, Fla., just south of the study area, a vertical hydraulic conductivity of the upper confining unit of 1.1×10^{-2} ft/d and a leakance of 3.8×10^{-4} d^{-1} were determined by using a geometric analysis of the potentiometric surface (Bermes and others, 1963, fig. 26). For the analysis, the assumption was made that flow conditions were at steady state; transmissivity was known from aquifer-test analyses, and the water-table altitude was known. Leakage through the unit under the prevailing vertical head difference of 2.5 ft would be 4.2 in/yr.

The materials that make up the upper confining unit vary greatly in lithology and permeability and are complexly interlayered throughout a vertical section. Although values of the vertical hydraulic conductivity of the upper confining unit vary by orders of magnitude within a vertical section, a composite or average value for the full section probably does not vary much areally. Thus, the leakance of the upper confining unit would vary inversely with its thickness (pl. 4).

Under these conditions, leakances would be lowest in the Southeast Georgia embayment where the upper confining unit is thickest, and highest where the unit is thinner, as in the area updip from the Gulf Trough. Leakance is greatest in areas where the upper confining unit is largely absent, as along the major rivers updip from the Gulf Trough, and in the areas of Valdosta, Ga., Keystone Heights and Green Cove Springs, Fla., and Beaufort County, S.C. (fig. 11). Leakance of the upper confining unit shown in figure 11 is based on the thickness of the unit and the results from the simulation of the flow system (discussed in Supplement I).

The vertical hydraulic conductivity of the middle semiconfining unit is known only from laboratory analysis of five cores of two wells in Brunswick, Ga. The vertical hydraulic conductivity of the dolomitic limestone making up the middle semiconfining unit ranged from 4.0×10^{-6} to 5.4×10^{-5} ft/d. Leakance of the unit, which is about 100 ft thick and has an estimated vertical hydraulic conductivity of 1×10^{-5} ft/d, would be extremely low—about 1×10^{-7} d^{-1}. Leakage through that unit under a 7-ft head difference would be only 0.003 in/yr. The low vertical hydraulic conductivity and leakance is understandable for the dense dolomitic 100-ft-thick limestone. However, fractures and faults are known to be present in the Jacksonville, Fla., and Brunswick, Ga., areas and probably along the entire coast, and such fractures and faults would markedly increase the vertical hydraulic conductivity and leakance of this unit.

Field data for the lower semiconfining unit are unavailable. The hydraulic properties of the unit are known only from simulation.



Base from U.S. National Atlas, 1970

EXPLANATION

Leakance, in feet per day per foot

Less than 10^{-6} | 10^{-6} to 10^{-5} | 10^{-5} to 10^{-4} | More than 10^{-4}

FIGURE 11.—Estimated leakance distribution of the upper confining unit of the Floridan aquifer system.

PREDEVELOPMENT GROUND-WATER-FLOW SYSTEM

Ground-water flow in the Floridan aquifer system is controlled chiefly by rates and distribution of recharge to and discharge from the system, the extent and effects of confinement, and the ability of the aquifers to transmit and store water. Prior to development, the flow system is considered to have been at dynamic equilibrium and the potentiometric surfaces nearly unchanged from year to year. Recharge to the aquifers was balanced by natural discharge, resulting in no change in storage in the aquifer system on a long-term-average basis. Only seasonal and short-term climatic fluctuations affected the altitude of the potentiometric surface.

Dynamic changes to the flow system resulting from post-Pleistocene sea-level changes probably occurred prior to development. These changes would have altered all components of the predevelopment flow system—recharge and discharge, heads, flows, and the location of the freshwater-saltwater interfaces. However, sufficient time probably has elapsed for the flow system to reach equilibrium, and, therefore, steady-state conditions were assumed for this study.

POTENTIOMETRIC SURFACE

The estimated predevelopment potentiometric surface of the Upper Floridan aquifer in the study area is shown on plate 9 and is based on those by Johnston and others (1980) and by Krause (1982, pl. 2). Data used to construct these maps were (1) historic data gathered prior to development in areas that later had significant ground-water development, and (2) recent data from areas where development has had an insignificant effect on the potentiometric surface. Although the predevelopment potentiometric surface shown on plate 9 is that of the Upper Floridan aquifer, some data used in its construction were from wells that probably tap water-bearing zones in the lower part of the overlying Hawthorn Formation that are not considered part of the Upper Floridan aquifer. The water level in these wells would be slightly higher or lower than that in the Upper Floridan, depending on the vertical head gradient. Therefore, plate 9 shows the general configuration of the predevelopment potentiometric surface of the Upper Floridan aquifer in the study area and is not an accurate representation of site-specific water levels.

In the upgradient areas along the major rivers, especially the Savannah River, contours of the potentiometric surface on plate 9 differ slightly from those of Johnston and others (1980) and Krause (1982, pl. 2) because of the inclusion of more recent data. A recent investigation by Faye and Prowell (1982, fig. 8) indicates that a greater relation exists between the aquifer and the Savannah River than previously thought. The head in the aquifer is significantly lower near the river than away from the river, indicating that the aquifer discharges into the river. For that reason, the potentiometric contours in the vicinity of the river are markedly bent upgradient.

Although the relation between the aquifer and the other major upgradient rivers has not been documented, a similar steep gradient and discharge relation undoubtedly exists. These rivers exert more influence on the aquifer, as manifested in the potentiometric contours, than is shown on plate 9. The amount of influence would be related to the degree of river entrenchment, the thickness and leakance of material separating the aquifer and the riverbed, and the resistance to downgradient ground-water flow caused by the Gulf Trough, as well as to the head in the aquifer and the stage in the river.

COMPONENTS OF THE PREDEVELOPMENT GROUND-WATER-FLOW SYSTEM

Under predevelopment, steady-state conditions, recharge was equal to discharge and no change in aquifer storage took place. Recharge generally occurred in upgradient areas, producing high head. Water then flowed downgradient toward the coast and discharged in areas of lower head (pl. 9). The simulation indicates that total flow through the Floridan aquifer system in the study area prior to development was about 1,400 ft^3/s. Table 4 shows the simulated components and distribution of flow through the aquifer system prior to development.

The simulated distribution of vertical flow, or leakage, under predevelopment, steady-state conditions through the upper confining unit is shown on plate 10. The leakage is expressed in inches per year.

The area of highest recharge to the aquifer system prior to development was chiefly updip and upgradient from the Gulf Trough, where the aquifer system is exposed or thinly covered and least confined. In this area, recharge occurred in the topographically high areas, either directly into the exposed or thinly covered Upper Floridan or through the upper confining unit where the head in the surficial aquifer was higher than the head in the Upper Floridan. Flow through the Upper Floridan aquifer in this updip area was chiefly toward the major rivers, where the water was discharged. The components and areal distribution of simulated flow through the aquifer system prior to development are shown in figure 12.

In the area updip from the Gulf Trough, about 750 ft^3/s was recharged to the Upper Floridan from the surficial

TABLE 4.—*Simulated water budget for predevelopment (1880) and present-day (1980) flow systems*

[Negative number denotes opposite flow direction; values are rounded off only enough to maintain the numerical balance of the water budget; implication of accuracy to the degree shown is not intended]

	Simulated flow, in cubic feet per second													Pumpage, in cubic feet per second	
	Total flow		Net vertical leakage			Lateral boundary flow									
						Lower Floridan					Upper Floridan				
	In	Out	Surficial aquifer to Upper Floridan	Lower Floridan to Upper Floridan	Fernandina permeable zone to Lower Floridan	Northern inflow	Southern outflow	Eastern outflow	Northwestern inflow	Southwestern inflow	Southern outflow	Eastern outflow	Southwestern inflow	Upper Floridan	Lower Floridan
Predevelopment	1,400	1,400	-329	383	40	338	47	2	60	0	51	2	0	0	0
Present-day	2,100	2,100	92	612	282	338	47	-2	60	70	34	-6	201	878	93

aquifer and 990 ft³/s was discharged from the Upper Floridan, primarily to the major rivers. About 90 ft³/s infiltrated to the Lower Floridan, 456 ft³/s migrated from the Lower Floridan to the Upper Floridan, and 126 ft³/s migrated downgradient in the Upper Floridan through the Gulf Trough.

Circulation within the Lower Floridan in the area upgradient from the Gulf Trough was similar to that in the Upper Floridan, but of a smaller magnitude. In addition, because the Lower Floridan here is composed chiefly of clastic material, most of the flow occurred within these clastics, which are not a part of the (predominantly carbonate) Floridan aquifer system as defined by Miller (1985). The Lower Floridan was recharged with about 90 ft³/s from the Upper Floridan through the middle semiconfining unit. Because the clastic facies of the Lower Floridan aquifer extend farther updip and upgradient than shown and simulated herein, flow occurred from the clastics across the upgradient boundary of the model. This boundary flow was simulated to be about 338 ft³/s from the north and about 60 ft³/s from the northwest (fig. 12). The Lower Floridan discharged about 456 ft³/s through the middle semiconfining unit into the Upper Floridan. About 32 ft³/s remained in the Lower Floridan as downgradient flow through the Gulf Trough (fig. 12).

The small quantity of flow passing downgradient through the Upper and Lower Floridan aquifers across the Gulf Trough, compared with the total flow in the area upgradient from the trough, further supports the existence of an active but nearly isolated flow system in the Floridan upgradient from the Gulf Trough.

Ground-water contribution from the Floridan aquifer system to the major rivers and their tributaries in the area upgradient from the Gulf Trough was estimated from field data and subsequently simulated by the model. The estimates of the ground-water contribution were based largely on streamflow records from 13 gaging stations on the four major rivers: Ocmulgee, Oconee, Ogeechee, and Savannah. Summaries of 1-day, 7-day, and monthly minimum average flows made during the 1954 drought (Thomson and Carter, 1955, 1963) and annual low-flow data for periods of record were used. In addition, total discharge determined from instantaneous low-flow measurements made in tributaries to the major rivers was considered to be ground-water contribution to the streamflow.

The ground-water contribution of the Floridan aquifer system to the major rivers and their tributaries in the area upgradient from the Gulf Trough is considerably less than the observed base flow. A large part of the base flow is contributed by sources other than the Floridan aquifer system (most of which was not simulated by the model). These sources are the surficial aquifer and the updip clastic equivalents of the Floridan aquifer system. Stricker (1983) calculated the base flow to unregulated streams in selected basins in the Cretaceous-Tertiary outcrop area, which included part of this study area. Stricker used the method of hydrograph separation and concluded that discharges at the 65-percent duration point of flow-duration curves were good estimates of mean annual base flow. Using this criterion, an estimate of the base flow in most of the area upgradient from the Gulf Trough could be about 8 in/yr (Bush and Johnston, 1986). In this area, the local flow system (surficial aquifer) contributes most of the water to the base flow. Water in this local flow system either does not reach the Upper Floridan or, where it does and the Upper Floridan is the surficial aquifer, circulates on a scale that is smaller than that herein considered and simulated as part of the Floridan aquifer system. The Floridan aquifer system in this area probably contributes only about 1,000 ft³/s, or about 2 in/yr, to the base flow of the major rivers and their tributaries.

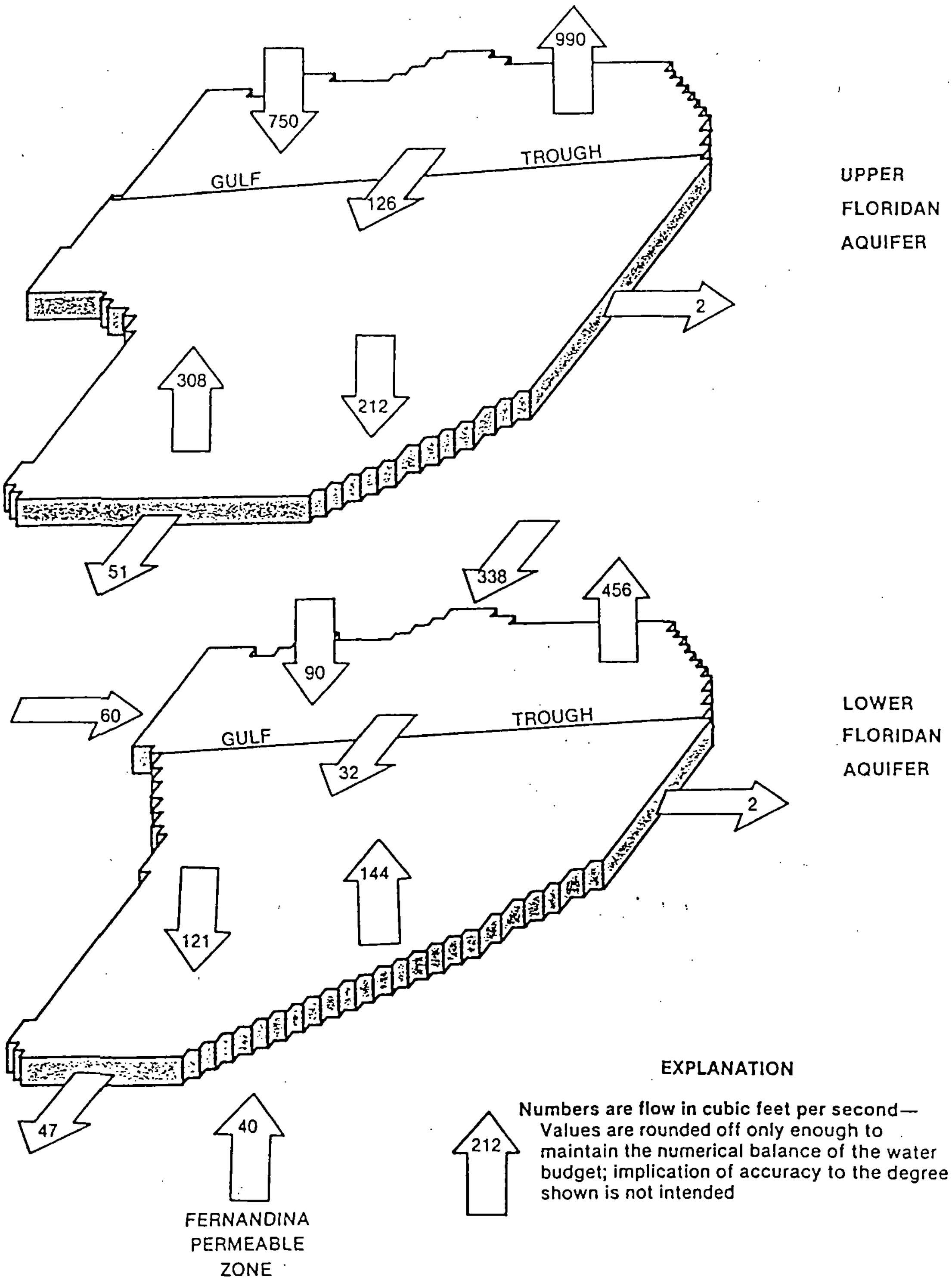


FIGURE 12.—Simulated components and areal distribution of flow through the Floridan aquifer system prior to development.

Total ground-water contribution to the major rivers was apportioned among the three aquifers: surficial (where different from the Upper Floridan aquifer), Upper Floridan, and Lower Floridan (which, in this area, is composed predominantly of clastic beds) on the basis of hydrogeologic framework and hydraulic characteristics of the aquifers. Estimated and simulated values are listed below.

Aquifer		Ground-water contribution to streamflow, in ft³/s			
		River			
		Ocmulgee	Oconee	Ogeechee	Savannah
Surficial[1]	Estimated	50	25	25	50
Upper Floridan	Estimated	220	80	70	190
	Simulated	247	83	68	200
Lower Floridan	Estimated	120	30	10	240
	Simulated	99	34	14	260
Total Floridan aquifer system	Estimated	340	110	80	430
	Simulated	346	117	82	460
Total	Estimated	390	135	105	480

[1]Surficial aquifer was not simulated.

Downgradient from the Gulf Trough, the flow system was more sluggish, characterized by flat gradients, high aquifer transmissivities, low velocities, and, with some exceptions, low recharge and discharge rates. Recharge and discharge over most of the downgradient area were chiefly low rates of diffuse infiltration or leakage. It is doubtful that the highly transmissive, cavernous nature of the aquifer system was developed under these conditions; it probably developed in the geologic past, as a result of either Pleistocene sea-level fluctuations, or, more likely, karstification during exposure of the Floridan carbonates shortly after deposition during Tertiary time. (See Miller, 1985, chapter B of this Professional Paper series, for a complete discussion of cavernous permeability development.)

The Upper Floridan aquifer in the area downgradient from the Gulf Trough received about 126 ft³/s as lateral downgradient flow through the trough (fig. 12). Recharge from the surficial aquifer to the Upper Floridan aquifer was about 212 ft³/s, and discharge from the Upper Floridan to the surficial aquifer was about 308 ft³/s, resulting in a net discharge of 96 ft³/s. Most of the recharge from the surficial aquifer to the Upper Floridan occurred as diffuse infiltration where the hydraulic gradient was downward in the large inland area away from the coast. Most of the discharge from the Upper Floridan to the surficial aquifer was diffuse upward leakage where the hydraulic gradient was upward, primarily in the coastal area. Discharge was concentrated in the Savannah, Ga., area, and along the St. Johns River, including Green Cove Springs, in Florida, where the upper confining unit is thin and locally absent.

Northeast Florida had the most active part of the predevelopment flow system downgradient from the Gulf Trough. There, the Upper Floridan aquifer is near land surface, and in places the upper confining unit is breached. Sinkholes, sinkhole lakes, sinking streams, and springs make this area typically karst. Recharge to the Upper Floridan, based on simulation, was about 60 ft³/s in the area near Keystone Heights in western Clay County, Fla. (pl. 10). Much of the water that recharged the aquifer near Keystone Heights was discharged in springs such as Green Cove Springs near the St. Johns River and unnamed springs along that river. Discharge also occurred as diffuse upward leakage from the Upper Floridan where leakance and head differences were favorable along the St. Johns River, totaling about 50 ft³/s.

Significant recharge to the Upper Floridan also occurred near Valdosta, Ga., where about 100 ft³/s enters the aquifer (Krause, 1979, p. 26), about 17 ft³/s of which enters the study area from the southwest. North of Valdosta, part and sometimes all of the Withlacoochee River flows into swallow holes that are interconnected with the aquifer (Krause, 1979, p. 11).

Recharge to the Upper Floridan aquifer of about 8 ft³/s occurred near Beaufort, S.C., where the aquifer is thinly covered. Discharge occurred nearby in deeply scoured reaches of creeks and estuaries near Hilton Head Island, S.C. (pl. 10).

In the area downgradient from the Gulf Trough, the Upper Floridan discharged about 51 ft³/s across the southern boundary into Florida and offshore and about 2 ft³/s into South Carolina and offshore across the eastern boundary. The Lower Floridan discharged about 144 ft³/s to the Upper Floridan aquifer, largely as diffuse upward leakage in the downgradient area along the coast where the vertical hydraulic gradient was upward. The Upper Floridan recharged the Lower Floridan at a rate of about 121 ft³/s, chiefly in the upgradient area near the Gulf Trough where the hydraulic gradient was downward (fig. 12).

The Lower Floridan aquifer in the area downgradient from the Gulf Trough received about 32 ft³/s as downgradient flow through the trough and discharged about 47 ft³/s and 2 ft³/s across the southern and eastern boundaries, respectively. The Lower Floridan had a net discharge of about 23 ft³/s to the Upper Floridan and received about 40 ft³/s from the Fernandina permeable zone (fig. 12). Because the hydraulic characteristics of the Fernandina permeable zone are poorly known and only roughly estimated, the simulated flux of 40 ft³/s may be in significant error.

The Fernandina permeable zone was fairly inactive prior to development. The approximately 40 ft^3/s that discharged from the zone into the rest of the Lower Floridan aquifer occurred chiefly along the northeast Florida–southeast Georgia coast where the lower semiconfining unit is breached by faults (Leve, 1966; Gregg and Zimmerman, 1974). It is thought that water in the Fernandina permeable zone is, in part, relict or partially flushed connate water, probably having a nearly horizontal freshwater–saltwater interface. If the small quantity of water that leaked from the Fernandina permeable zone along the coast is approximately the same as the simulated quantity, that leakage probably did not significantly move the freshwater–saltwater interface within the zone. Although not known, the source of water that replaced the water lost by the zone may have been the Lower Floridan aquifer in central Florida, where the Fernandina permeable zone may merge with the rest of the Lower Floridan aquifer, or it may be modern seawater from the offshore area, or a combination of the two.

Downgradient from the Gulf Trough, for example in Jeff Davis County, Ga., where the head in the surficial aquifer was higher than the head in the Upper Floridan, circulation included diffuse recharge and downgradient flow (pls. 9, 10; fig. 13). Figure 13 is a schematic showing the predevelopment flow system in the Floridan aquifer system in the study area along a hypothetical flow line. Farther downgradient toward the southeast, the gradient between the surficial and Upper Floridan aquifers changed direction and discharge occurred. Still farther downgradient, near the coast, the head in the Upper Floridan exceeded land surface altitude and flowing wells were obtainable; diffuse upward discharge and downgradient flow still occurred (pls. 9, 10; fig. 13). Similar flow circulation of lesser quantities existed in the Lower Floridan aquifer.

The downgradient limit to the predevelopment freshwater flow system in the Upper Floridan was estimated to be near and approximately parallel to the Florida-Hatteras Slope (pl. 9). This limit for the aquifer flow system corresponds to the freshwater–saltwater interfaces within the aquifers (fig. 13).

The position of the freshwater-saltwater interface was estimated on the basis of an equation described by Hubbert (1940, p. 872). The assumption of the equation is that at the interface, pressure created by the freshwater head is balanced by pressure created by the saltwater head. The interface equation assuming flowing freshwater, static saltwater, and a sea-level datum is

$$Z=\left[\frac{p_f}{p_s-p_f}\right]\cdot h_f,$$

where

Z = altitude of the interface above a datum,
p_f = density of freshwater,
p_s = density of saltwater, and
h_f = freshwater head at the interface.

If p_f is assumed to be 1.000 g/cm^3 for freshwater and p_s to be 1.025 g/cm^3 for seawater, then

$$Z=40h_f.$$

This relation indicates that the depth below sea level to the base of freshwater is 40 times the altitude of the freshwater head at the interface. To estimate the interface position, it was assumed that the head at the interface was equal to the head of the potentiometric surface of the Upper Floridan as measured or estimated vertically above the interface. This condition is not precisely met because freshwater flow above the interface necessitates lines of equal head that are curved, not vertical. However, Johnston and others (1982, fig. 7) have shown that the interface offshore of southeast Georgia, which constitutes the limiting flow line of the freshwater flow system, has a very low slope. Therefore, freshwater flow lines near the interface must be nearly horizontal. This in turn suggests that the lines of equal head near the interface are nearly vertical. Thus, an estimate of the interface position based on heads higher in the section is probably acceptable.

PRESENT-DAY GROUND-WATER-FLOW SYSTEM

The present-day (1980) flow system reflects the changes that have occurred as a result of ground-water development. The flow system has undergone changes that involve water levels, rates and distribution of recharge and discharge, ground-water flow, and the quality of the water. Ground-water withdrawals primarily have lowered water levels, induced additional recharge and reduced natural discharge, and increased total flow through the system, and, to a lesser extent, have reduced aquifer storage, caused land subsidence (at Savannah), and degraded the quality of the water in places on the coast.

GROUND-WATER WITHDRAWAL

The first well drilled into the Floridan aquifer system in the study area was in Savannah, Ga., in 1885 (McCallie, 1898, p. 64). The city of Savannah began using ground water from the Upper Floridan in 1886, and by 1900 more than 10 Mgal/d (15 ft^3/s) was withdrawn for municipal supply. Since then, development of ground water has spread throughout the area, chiefly along the coast, where flowing wells supplied suf-

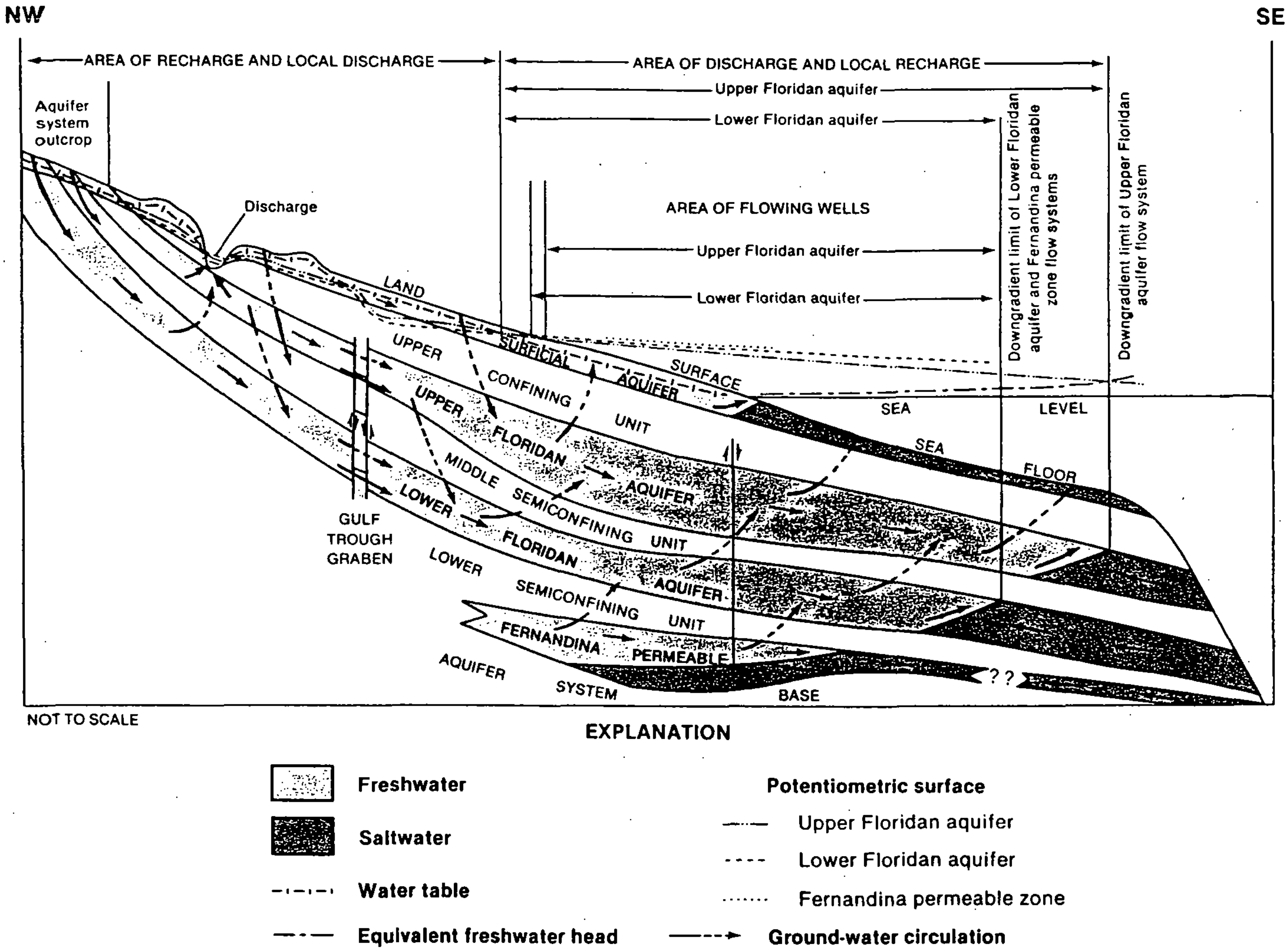


FIGURE 13.—Conceptual model of the predevelopment flow system for the Floridan aquifer system from the outcrop area in the northwest to the offshore area in the southeast.

ficient water to most users. Development continued to increase gradually, initially for municipal, domestic, and small commercial supplies. Large industries, chiefly paper manufacturers, located plants in the area and began to withdraw increasingly large quantities of water from the Upper Floridan, primarily along the coast. With the exception of the city of Jacksonville, Fla., the largest users of ground water are industries, and the major pumping centers are those that include ground water withdrawn by the pulp and paper industry.

In 1980, the total estimated ground-water withdrawal from the Floridan aquifer system in the study area was approximately 625 Mgal/d (970 ft^3/s). The distribution of pumpage for the study area by aquifer is shown on plate 11. The pumpage data were largely derived from Pierce and others (1982) for Georgia, Hayes (1979, p. 51, fig. 20) for South Carolina, and unpublished records (E.C. Hayes, U.S. Geological Survey, written commun., May 1981) for Florida. About 90 percent of the withdrawal was from the Upper Floridan. The 10 percent withdrawn from the Lower Floridan (about 93 ft^3/s) was chiefly in the Jacksonville area, where deep municipal and industrial wells tap both aquifers. A small quantity was withdrawn from the Lower Floridan in the outcrop area in Georgia, where neither aquifer is very productive, and in the area of South Carolina, where the Upper Floridan yields little water (pl. 11; table 4).

POTENTIOMETRIC SURFACE AND WATER-LEVEL DECLINE

The most obvious impact of ground-water withdrawal on the flow system has been the lowering of water levels. Large withdrawal of ground water along the coast has produced large cones of depression, which in places have overlapped, and generally has lowered potentiometric surfaces as far upgradient as the Gulf Trough (pl. 12). The potentiometric surface for May 1980 shown on plate 12 is that of the Upper Floridan aquifer in the study area, and is based on a similar map covering the entire Floridan aquifer system described by Johnston and others (1981). Although the potentiometric surface in the area upgradient from the Gulf Trough is believed to have been unaffected by ground-water development, the potentiometric surfaces for predevelopment (pl. 9) and present-day conditions (pl. 12), differ in that area. The present-day (1980) potentiometric surface is based on nearly synchronous measurements made during May 1980, whereas the predevelopment potentiometric surface is a general configuration, as previously discussed.

The potentiometric surface of the Lower Floridan is about the same as that of the Upper Floridan shown on plate 12. Sufficient data are not available to construct a 1980 potentiometric surface for the Lower Floridan. However, downgradient from the Gulf Trough, limited head data from both aquifers indicate that the head in the Lower Floridan is only slightly higher than that in the Upper Floridan. Maximum differences in heads between the Upper and Lower Floridan probably occur in the area of the deeper cones of depression and in areas where confinement is greatest and hence leakage is least. Fairchild and Bentley (1977, p. 13) indicated that at Fernandina Beach, Fla., the head in the Lower Floridan is as much as 20 ft higher than that in the Upper Floridan. This head difference probably represents a maximum; generally, head differences are less than 5 ft (fig. 9). However, locally in recharge areas upgradient from the Gulf Trough, where little withdrawal from the Upper Floridan has occurred since predevelopment, the head probably remains lower in the Lower Floridan. Similarly, head in the Lower Floridan is lower than in the Upper Floridan in the recharge areas near Keystone Heights, Fla., and Beaufort, S.C.

The deeper cones of depression of the potentiometric surfaces are in the areas of larger, concentrated ground-water withdrawal, such as Savannah, Ga., and Fernandina Beach, Fla. However, available water, supplied by lateral or vertical flow, plays a large part in the magnitude of head decline. In Georgia, pumpage at Brunswick is about 30 percent greater than that at Savannah, but higher transmissivity and leakance make more water available at Brunswick, thus producing a much shallower cone of depression. Pumpage of nearly 130 Mgal/d (200 ft^3/s) at Jacksonville, Fla., has produced an almost imperceptible cone for the same reasons, chiefly high leakage rates (pl. 12). Lowering of the potentiometric surface along the coast, especially near Savannah, has decreased the area where wells tapping the Floridan aquifer system would have flowed in 1980. Upgradient from the Gulf Trough, where head decline has been minimal, the area where wells would have flowed has changed little, if any (pls. 12, 13).

The head-decline map, plate 13, is based on the predevelopment and present-day (1980) potentiometric surfaces of the Upper Floridan aquifer shown on plates 9 and 12, respectively. Points of data used to contour the head-decline map were derived from the differences in head values at the intersections of superposed contours from the potentiometric-surface maps (pls. 9, 12). Interpolated contours from both potentiometric-surface maps were also used to increase the density of data points and to better define the lines of equal decline. The map showing head decline indicates the change that the potentiometric surface has undergone as a result of development, chiefly that of significant declines in the coastal area.

As shown on plate 13, almost the entire study area is encompassed by a line of zero head decline. The location of the inferred line of zero head decline offshore near the estimated position of the freshwater–saltwater interface in the Upper Floridan would indicate that little movement, or in places possibly no movement, of the interface has occurred since development. Little field data are available to support this contention. Head and salinity data are available only from an abandoned Tenneco, Inc., oil-test well and three other exploratory wells in the offshore area (Johnston and others, 1982, fig. 1, p. 12). The interface within the Upper Floridan at the Tenneco, Inc., site about 55 mi offshore from Fernandina Beach, Fla., seems to be transient between the position that would be compatible with the predevelopment heads and the position that would be compatible with present-day heads. This implies that some movement of the interface probably has occurred since development (Johnston and others, 1982, p. 12). Locally, at Brunswick, Ga., Fernandina Beach, Fla., and St Marys, Ga., saltwater intrusion into the Floridan aquifer system has occurred, indicating some vertical component of movement of the interface (fig. 14).

In the northwest part of the study area, the upgradient limit of head decline (line of zero head decline) lies along the Gulf Trough. Because the trough impedes the downgradient flow of water through the aquifer, it similarly limits the upgradient expansion of head decline. Head decline in the area upgradient from the trough has been negligible because the trough limits the

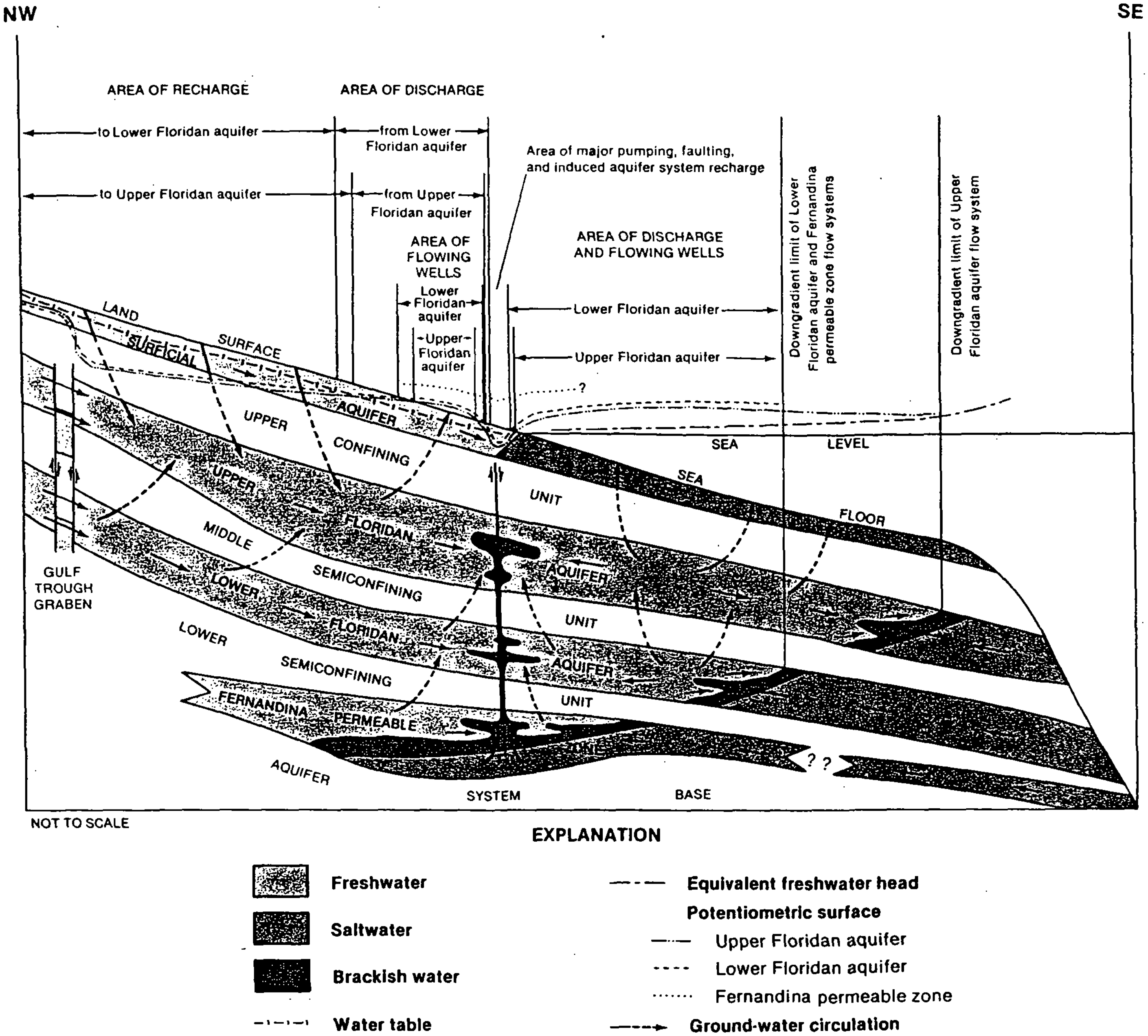


FIGURE 14.—Conceptual model of the present-day (1980) flow system for the Floridan aquifer system from the Gulf Trough in the northwest to the offshore area in the southeast.

expansion of head decline, and because of high rates of recharge and low rates of ground-water withdrawal in the area. An observation well (21T1) near Dexter (the outcrop area) in western Laurens County, Ga., indicates marked seasonal and climatic fluctuations but shows no long-term decline for the period 1964–82 (fig. 15; well location shown on pl. 13). Locally, small declines in head probably have occurred in municipal pumping centers upgradient from the trough, although the extent is unknown because of a lack of data.

Head decline in the area of the trough ranges from little or none at its upgradient side, to 15 to 30 ft at its downgradient side. Locally, head declines are probably greater within areas of the trough having lower transmissivities and moderate ground-water withdrawals. Observation wells in Vidalia, Toombs County (26R1), and Uvalda, Montgomery County (25Q1), within the graben system of the Gulf Trough, indicate head declines of about 1 ft/yr since 1974 and 1966, respectively (fig. 15; well locations shown on pl. 13).

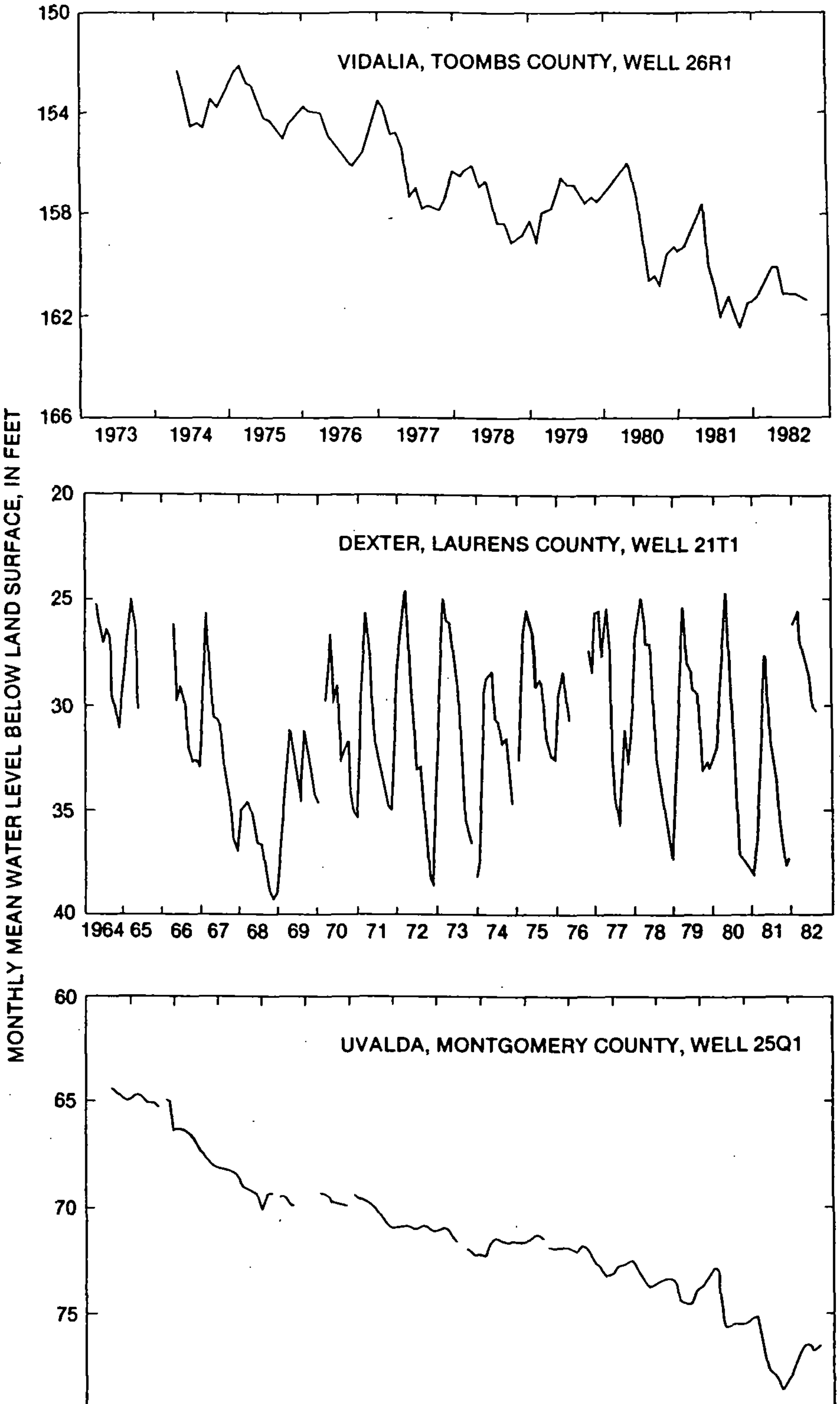


FIGURE 15.—Long-term water-level fluctuations in the Upper Floridan aquifer in Toombs, Laurens, and Montgomery Counties, Ga.

Recharge to the Upper Floridan near Valdosta, Ga., Beaufort, S.C., and Keystone Heights, Fla., limits the head decline near those areas caused by pumping throughout the study area (pl. 13). Heads in the aquifer near the areas of Valdosta, Ga., Beaufort, S.C., and Keystone Heights, Fla., showed seasonal fluctuations in response to precipitation but almost no long-term decline. The water-level trend in the Upper Floridan aquifer in the Valdosta area is closely related to precipitation and streamflow because of the direct recharge of the Upper Floridan by the Withlacoochee River. This relation, shown in figure 16, uses streamflow data from the nearby Alapaha River at Statenville, as data are not available for the Withlacoochee River in the area. Locations of the observation well and the precipitation and streamflow stations are shown on plate 13.

Head decline in the Upper Floridan along the southwestern boundary of the study area has caused significant lateral flow across the boundary that did not exist before development. Some head decline also occurred along the southern boundary of the study area where water in the Upper and Lower Floridan aquifers flowed out of the study area prior to development.

The prominent cones of head decline at Savannah, Brunswick, and Jesup, Ga., have overlapped and produced a large area of head decline that encompasses the three pumping centers. This area is defined by the 30-ft line of equal head decline shown on plate 13. This area and the nearby deep cone of head decline at St Marys, Ga., and Fernandina Beach, Fla., are separated by an area of minimal head decline in Camden County, Ga. This minimal head decline and lack of overlapping of the two closely spaced, deep cones seems to be anomalous when compared with the overlapping cones at Savannah, Jesup, and Brunswick, Ga. Comparison of the maps showing transmissivity (pl. 8) and water-level decline (pl. 13) indicates that a relation exists between transmissivity distribution and water-level decline in the area between Brunswick, Ga., and Fernandina Beach, Fla. Relatively, the transmissivity of the Upper Floridan at Brunswick is large, is substantially less along the Glynn–Camden County line, is largest in Camden County, and is lowest at Fernandina Beach. This distribution of transmissivity, primarily the alignment of low values that acts as a permeability barrier along the Glynn–Camden County line, is probably responsible for the separation of the cones of water-level decline at Brunswick and Fernandina Beach. Simulation supports this hypothesis. In addition, unusually high upward leakage from the Lower Floridan into the Upper Floridan near the south end of Brunswick, Ga., could also produce the 1980 potentiometric surface and water-level decline in the areas of Brunswick, and St Marys, Ga., and Fernandina Beach, Fla., shown on plates 12 and 13, respectively. The upward-leakage hypothesis also is supported by field evidence and by simulation.

Long-term water-level declines in three observation wells within the cone of depression at Savannah are shown in figure 17. On the basis of the estimated predevelopment potentiometric surface shown on plate 9, the water level in the vicinity of the three observation wells was probably about 30 ft above land surface prior to development. Thus, the water level has declined an estimated 110 to 170 ft at the three observation wells since development began in the 1880's. In Savannah, gradual increases in municipal and industrial pumping caused the water level to decline, with periods of accelerated pumping producing the steeper declines shown in figure 17. During the fifties and early sixties, the water level declined rapidly in response to accelerated pumping. However, since the sixties the water-level decline has leveled off because of stabilized pumping rates (fig. 17).

Typical water-level trends in wells within the cones of depression at Brunswick, Ga., and Fernandina Beach, Fla., are shown in figure 18. Prior to development, the water levels in the vicinity of the wells were about 50 to 55 ft above land surface at Brunswick, and about 42 ft above land surface at Fernandina Beach. In both areas, the water level has declined to below land surface, owing mostly to industrial pumping. At Fernandina Beach, the aquifer has apparently reached equilibrium. At Brunswick, the water level continues to decline at a slow rate in well 33H133 near the center of pumping. However, other wells in the Brunswick area farther from pumping have shown nearly no decline during the past 10 years.

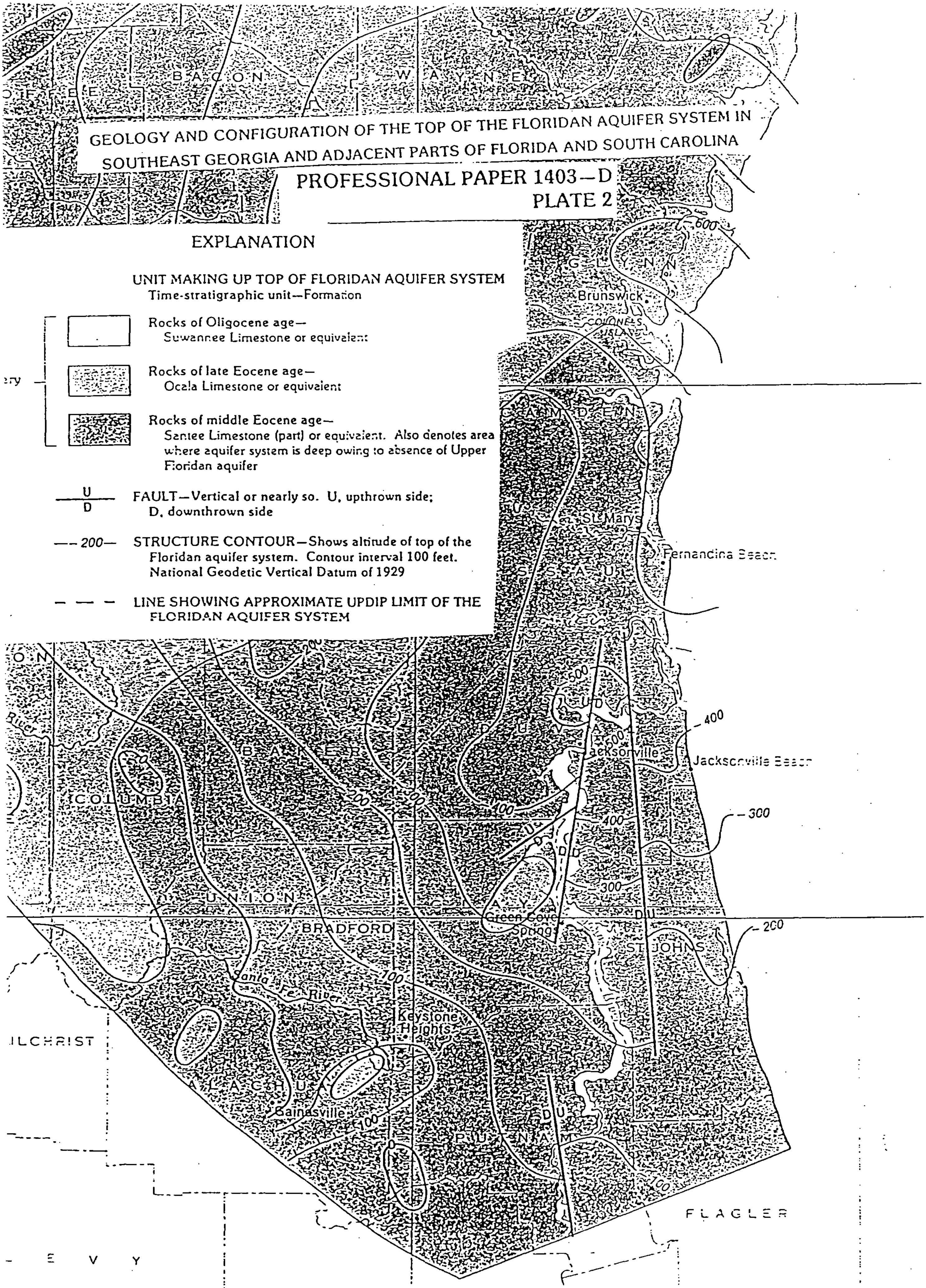
LAND SUBSIDENCE

As a result of water-level decline in the Floridan aquifer system in response to ground-water withdrawal, land subsidence has occurred in the area of Savannah, Ga. (Davis, Small, and Counts, 1963; Davis, Counts, and Holdahl, 1976). First, it should be noted that the subsidence at Savannah documented through 1975 was not significant enough to be recognized as an engineering problem, and would probably have gone undetected without precise leveling. Second, this subsidence should not be confused with crustal movements of regional scale, such as that reported by Holdahl and Morrison (1974) and Brown and Oliver (1976), or with coastal submergence as reported by Wait (1968).

Precise leveling in 1918, 1933, 1935, and 1955 indicated that subsidence of as much as 0.33 ft had occurred in the Savannah area, mostly since 1933 (Davis, Counts, and Holdahl, 1976, p. 350). By 1955, an area of

GEOLOGY AND CONFIGURATION OF THE TOP OF THE FLORIDAN AQUIFER SYSTEM IN SOUTHEAST GEORGIA AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA

PROFESSIONAL PAPER 1403—D
PLATE 2



EXPLANATION

UNIT MAKING UP TOP OF FLORIDAN AQUIFER SYSTEM
Time-stratigraphic unit—Formation

Rocks of Oligocene age—
Suwannee Limestone or equivalent

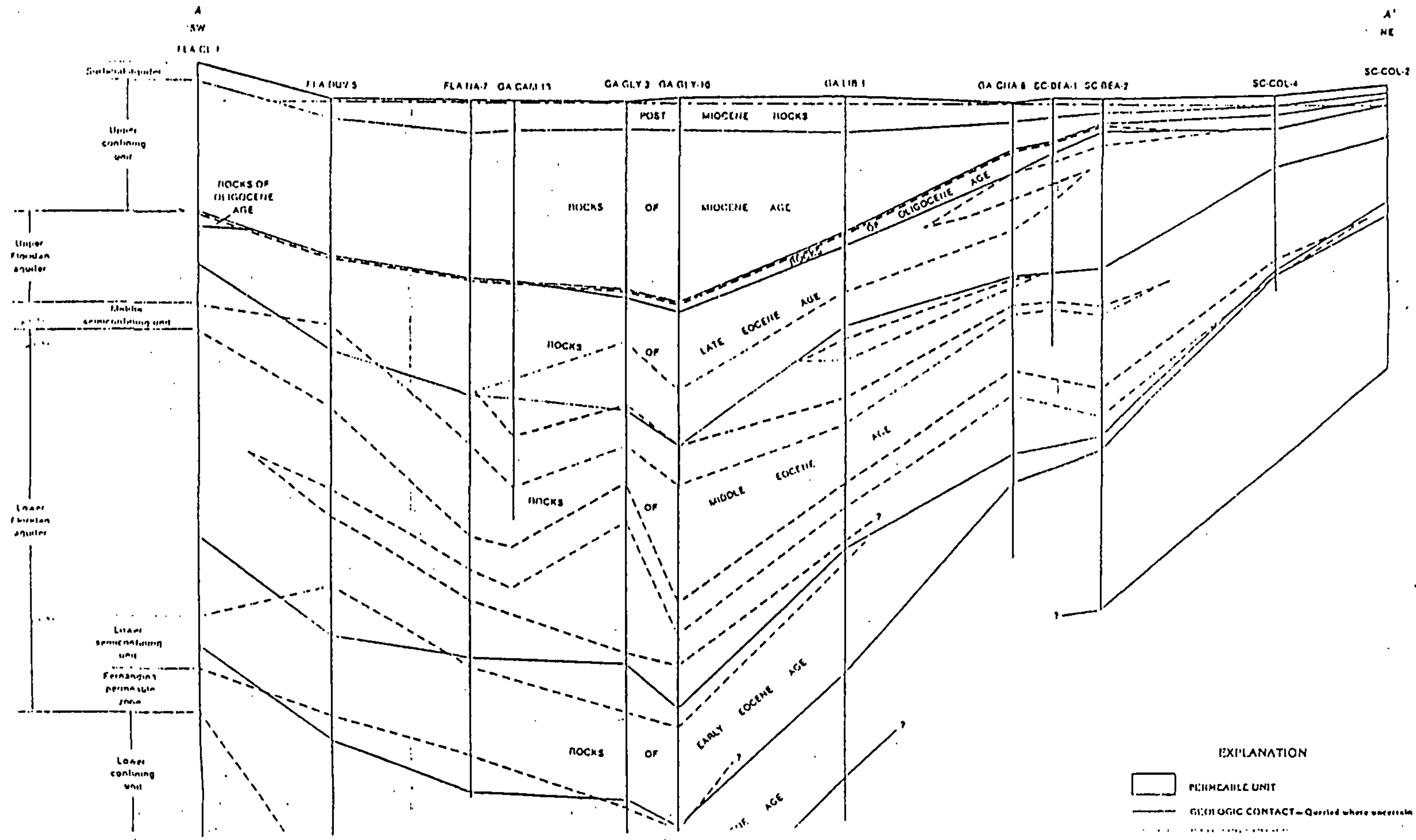
Rocks of late Eocene age—
Ocala Limestone or equivalent

Rocks of middle Eocene age—
Santee Limestone (part) or equivalent. Also denotes area where aquifer system is deep owing to absence of Upper Floridan aquifer

U/D FAULT—Vertical or nearly so. U, upthrown side; D, downthrown side

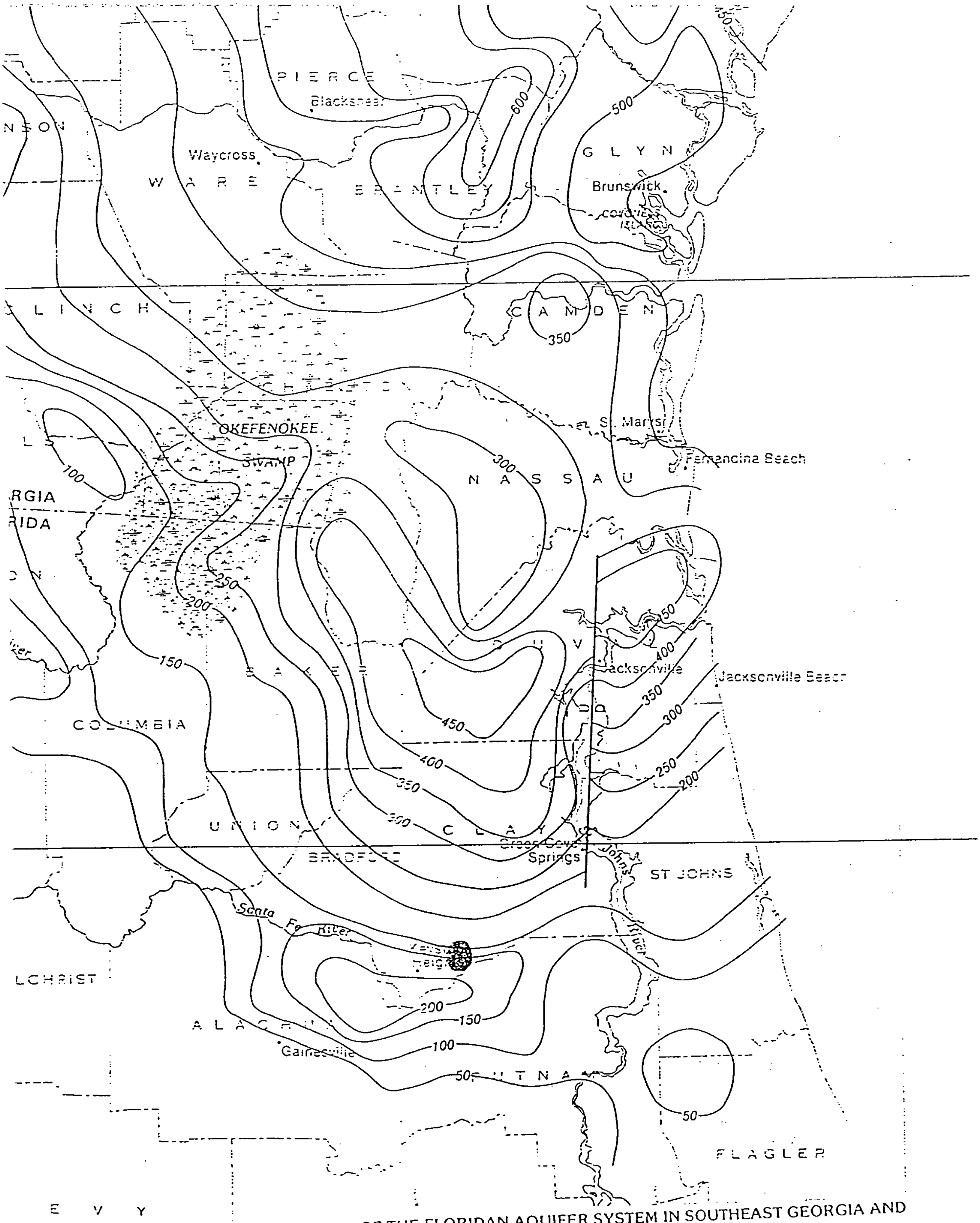
—200— STRUCTURE CONTOUR—Shows altitude of top of the Floridan aquifer system. Contour interval 100 feet. National Geodetic Vertical Datum of 1929

— — — LINE SHOWING APPROXIMATE UPDIP LIMIT OF THE FLORIDAN AQUIFER SYSTEM



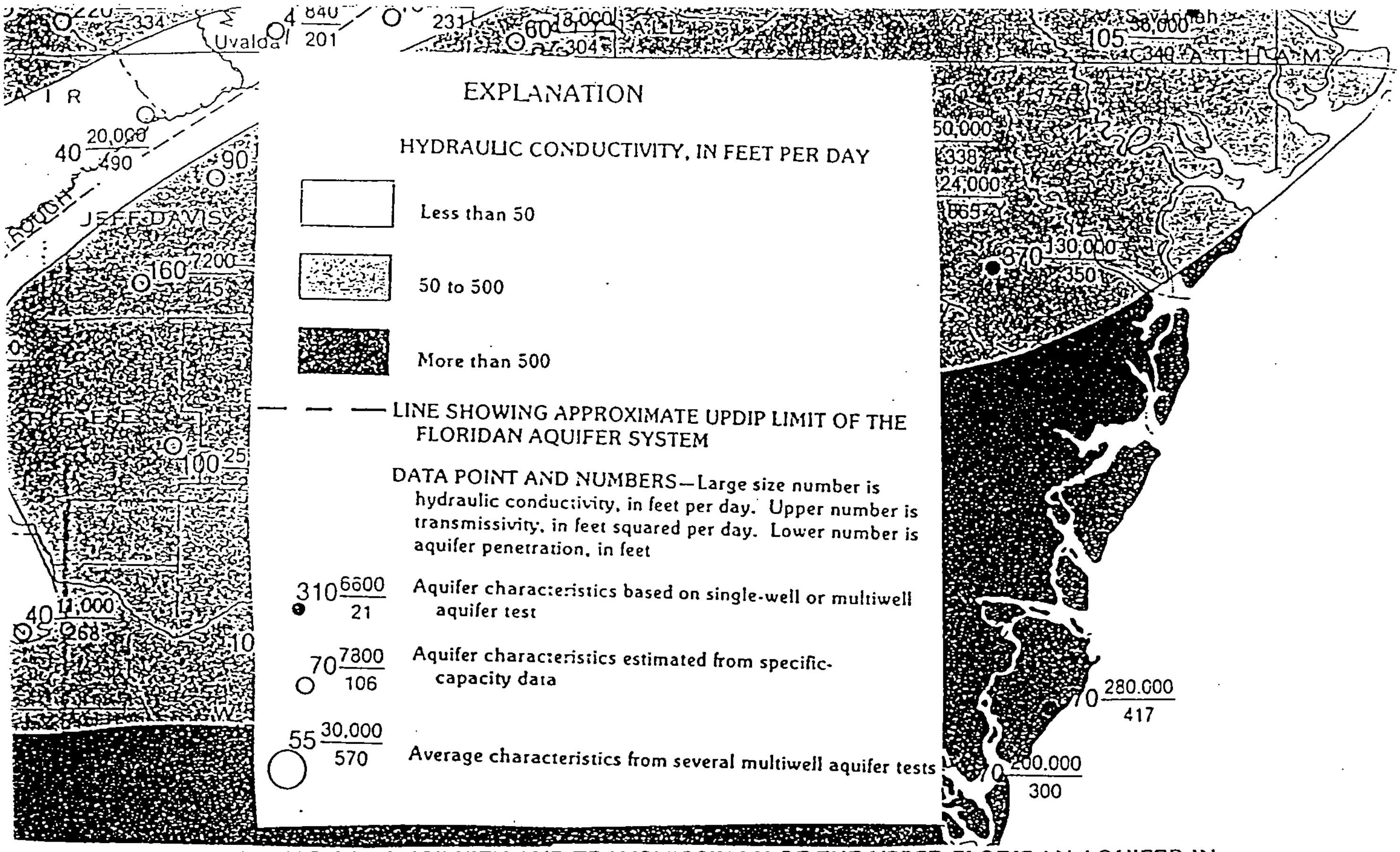
GENERALIZED HYDROGEOLOGIC SECTION SHOWING FLORIDAN AQUIFER SYSTEM ALONG THE ATLANTIC COAST, NORTHEAST FLORIDA TO SOUTHERN SOUTH CAROLINA

PROFESSIONAL PAPER 1403—D
PLATE 4

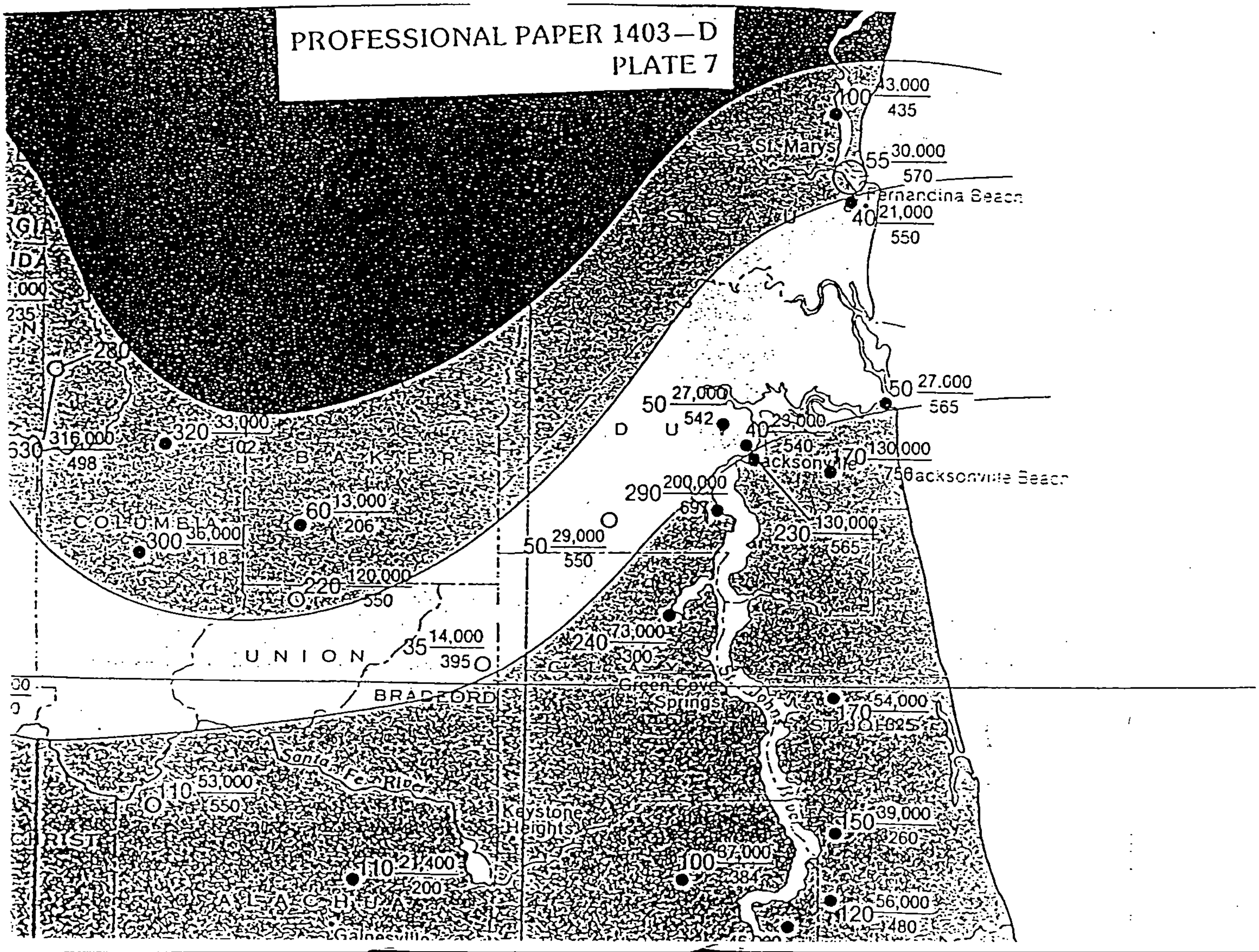


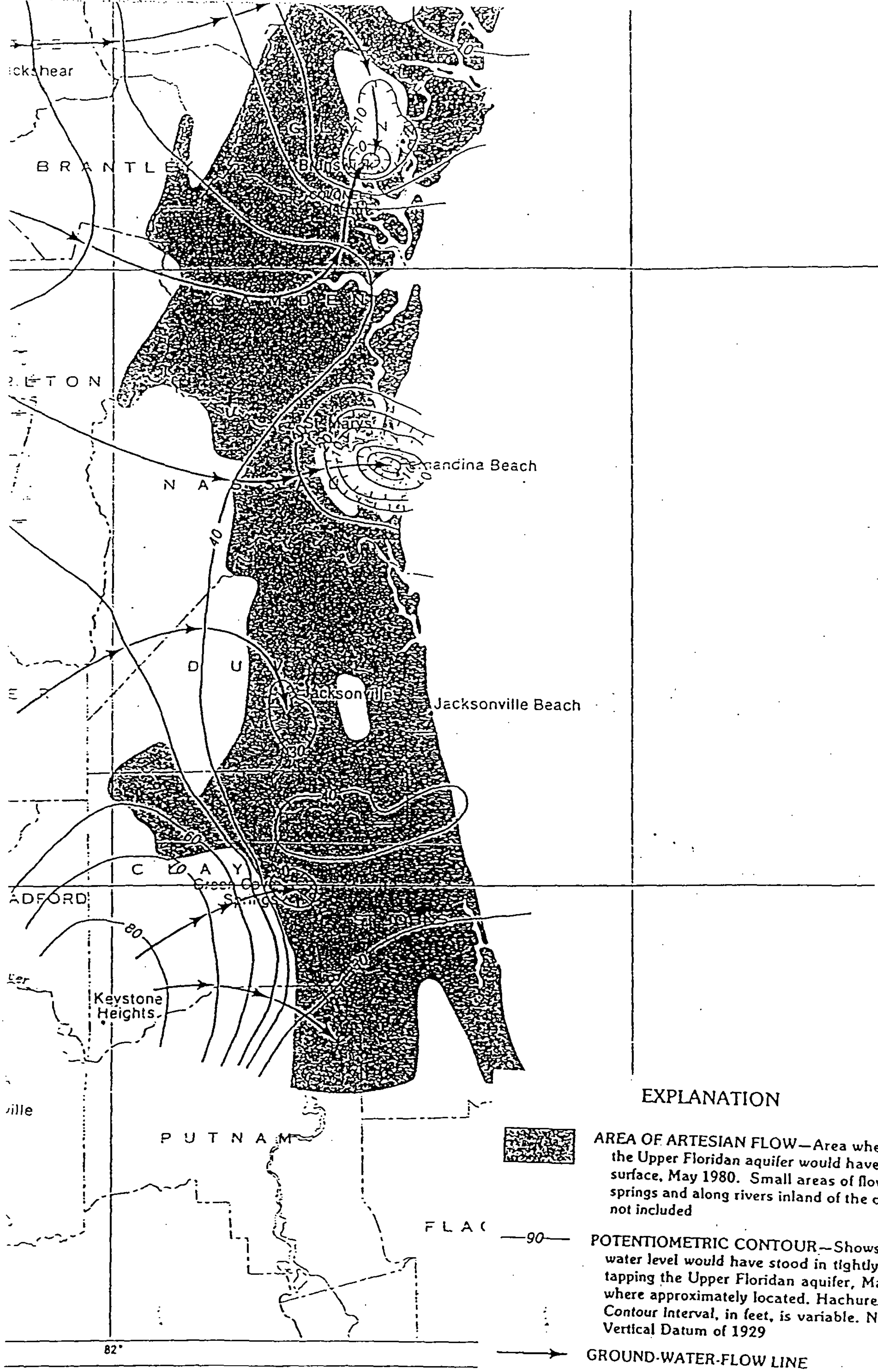
ICKNESS OF THE UPPER CONFINING UNIT OF THE FLORIDAN AQUIFER SYSTEM IN SOUTHEAST GEORGIA AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA

PROFESSIONAL PAPER 1403—D
PLATE 6



D VALUES OF HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY OF THE UPPER FLORIDAN AQUIFER IN SOUTHEAST GEORGIA AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA





EXPLANATION

AREA OF ARTESIAN FLOW—Area where wells tapping the Upper Floridan aquifer would have flowed at land surface, May 1980. Small areas of flow adjacent to springs and along rivers inland of the coastal area are not included

—90— POTENTIOMETRIC CONTOUR—Shows altitude at which water level would have stood in tightly cased wells tapping the Upper Floridan aquifer, May 1980. Dashed where approximately located. Hachures indicate depression. Contour Interval, in feet, is variable. National Geodetic Vertical Datum of 1929

GROUND-WATER-FLOW LINE

PROFESSIONAL PAPER 1403—D

PLATE 12

POTENTIOMETRIC SURFACE, AREA OF ARTESIAN FLOW, AND FLOW PATHS FOR THE UPPER FLORIDAN AQUIFER
... AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA, MAY 1980

I AO